EVALUATION OF THE IMPACT OF SEPARATE AND SHARED YELLOW SIGNAL SECTIONS AND HEAD ARRANGEMENTS FOR FLASHING YELLOW ARROW LEFT-TURN CONTROL

by

Daniel P. Reichl

A thesis submitted in partial fulfillment of
the requirements for the degree of

Master of Science
(Civil and Environmental Engineering)

at the
UNIVERISTY OF WISCONSIN – MADISON
2013
ABSTRACT

The objective of this research was to analyze the driver comprehension impacts of retrofitting existing traffic signal displays by installing a flashing yellow arrow indication in a bimodal traffic signal section with either the green arrow or yellow arrow indication. This research was completed by developing a computer-based static evaluation that asked participants how they would respond to a given set of signal indications when turning left. The participants were provided four responses, generalized as Go, Yield, Stop, or Don’t Know. Data collection was conducted in Madison, Wisconsin and Amherst, Massachusetts over a three week period in November and December, 2013. After completing the data collection effort, a statistical analysis was completed to determine the impacts of the various traffic signal indication combinations on driver comprehension.

The main focus of the analysis was to determine if the flashing yellow arrow was comprehended any differently when being combined with the green arrow (bottom) section compared to being combined with the yellow arrow (middle) section. Findings show that there was not a significant difference in driver comprehension when the flashing yellow arrow was displayed bi-modally in the bottom section or bi-modally in the middle section of a three-section vertical display or five-section clustered display without simultaneous indications. Driver comprehension was significantly lower when the flashing yellow arrow was added bi-modally to the five-section clustered display with simultaneous indications. It is recommended that the flashing yellow arrow is an acceptable retrofit for existing three-section vertical displays, but not for five-section clustered displays.
ACKNOWLEDGEMENTS

I would like to thank all of my fellow students and staff at the Traffic Operations and Safety Laboratory at the University of Wisconsin – Madison for their help and support while I was working on my thesis and other research projects. I would like to thank Dr. David Noyce for being my advisor and professor throughout my time in graduate school. I would like to thank Dr. Bin Ran and Dr. Soyoung Ahn for serving on my thesis committee and giving me helpful feedback. I would like to thank Andi Bill, Kelvin Santiago, and Rachina Ahuja for helping with developing the evaluation for my thesis and for helping with other research projects that I was involved with. I would also like to thank Mark Banghart for assisting me with the statistical analysis and teaching me the basics of R.
## TABLE OF CONTENTS

Abstract ............................................................................................................................. i  
Acknowledgements ......................................................................................................... ii  
Table of Contents ........................................................................................................... iii  
List of Figures .................................................................................................................. iv  
List of Tables ................................................................................................................... v  
List of Acronyms ............................................................................................................. vi  
1. Introduction .................................................................................................................. 1  
   1.1. Problem Statement ................................................................................................. 4  
   1.2. Research Objectives and Scope ........................................................................... 5  
   1.3. Research Methodology ........................................................................................ 6  
2. Literature Review ........................................................................................................ 8  
   2.1. Summary of Protected/Permissive Left-Turn Signal Control ............................... 10  
   2.2. Driver Comprehension Studies of Flashing Yellow Arrow ............................... 12  
   2.3. Field Studies of Flashing Yellow Arrow ................................................................. 29  
   2.4. Summary of Literature Review ............................................................................ 33  
3. Study Design .............................................................................................................. 34  
   3.1. Evaluation Development .................................................................................... 34  
   3.2. Evaluation Response Collection ......................................................................... 40  
4. Analysis and Results ................................................................................................. 41  
   4.1. Study Demographics ............................................................................................ 41  
   4.2. Initial Summary of Results ................................................................................... 42  
   4.3. Statistical Analysis ............................................................................................... 44  
   4.4. Observations from Evaluation ............................................................................. 62  
5. Conclusions and Future Work ................................................................................... 63  
   5.1. Conclusions .......................................................................................................... 63  
   5.2. Future Work ......................................................................................................... 66  
   5.3. Contributions ....................................................................................................... 67  
6. Appendix .................................................................................................................... 68  
   6.1. Evaluation Screenshots ....................................................................................... 68  
   6.2. Summary of Responses for All Scenarios ............................................................ 71  
   6.3. Evaluation Data Set .............................................................................................. 80  
   6.4. R Code .................................................................................................................. 247  
7. References .................................................................................................................. 306
LIST OF FIGURES

Figure 1-1. FYA Four-Section Vertical Display ................................................................. 3
Figure 2-1. Five-Section PPLT Signal Displays ................................................................. 10
Figure 2-2. Scenarios Evaluated in Previous Research Study Conducted
to Analyze Impacts of FYA Implementation ................................................................. 13
Figure 2-3. Scenarios Evaluated in Previous Research Study Conducted
to Analyze Impacts of Simultaneous Indications .......................................................... 16
Figure 2-4. Scenarios Evaluated in Previous Research Study Conducted
to Analyze Impacts of Various FYA Arrangements ......................................................... 18
Figure 2-5. Scenarios Evaluated in Previous Research Study Conducted
to Analyze Impacts of FYA at Intersections with Wide Medians ......................... 20
Figure 3-1. FYA Signal Displays to be Evaluated ............................................................. 36
Figure 3-2. Practice Question Used in Evaluation ............................................................. 38
Figure 3-3. Example FYA Question Used in Evaluation .................................................... 39
Figure 4-1. Percentage of Correct Responses for FYA Location Comparisons
based on Signal Display .................................................................................................... 51
Figure 4-2. Percentage of Fail-Critical Responses for FYA Location Comparisons
based on Signal Display ................................................................................................. 51
Figure 4-3. Percentage of Correct Responses for FYA Location Comparisons
based on Through Indication ......................................................................................... 55
Figure 4-4. Percentage of Fail-Critical Responses for FYA Location Comparisons
based on Through Indication ......................................................................................... 55
Figure 4-5. Percentage of Correct Responses in Wisconsin for FYA Location
Comparisons based on Signal Display and Through Indication ......................... 57
LIST OF TABLES

Table 3-1. Available Responses for Demographic Questions ........................................ 35
Table 3-2. Example of Raw Evaluation Data ............................................................... 40
Table 4-1. Summary of Demographic Information ....................................................... 41
Table 4-2. Summary of Results based on Display and FYA Section ................................. 43
Table 4-3. Formatting Associated with P Values ......................................................... 44
Table 4-4. Chi-Squared Analysis for FYA Location Comparisons .............................. 46
Table 4-5. Average Response Time based on FYA Location ..................................... 47
Table 4-6. Chi-Squared Analysis for Signal Display Comparisons ............................. 48
Table 4-7. Average Response Times based on Signal Display ....................................... 49
Table 4-8. Chi-Squared Analysis for FYA Location Comparisons ............................... 50
            based on Signal Display .................................................................................. 50
Table 4-9. Chi-Squared Analysis for Through Indication Comparisons ....................... 52
Table 4-10. Average Response Times based on Through Indication ........................... 53
Table 4-11. Chi-Squared Analysis FYA Location Comparisons ................................. 54
            based on Through Indication ............................................................................. 54
Table 4-12. Chi-Squared Analysis for Opposing Traffic Comparisons ....................... 58
Table 4-13. Average Response Times based on Opposing Traffic ............................... 58
Table 4-14. Chi-Squared Analysis for Driving Experience Comparisons .................... 59
Table 4-15. Chi-Squared Analysis for Age Comparisons ....................................... 59
Table 4-16. Average Response Times based on Driving Experience ............................ 61
Table 4-17. Average Response Times based on Age ............................................. 61
# LIST OF ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CG</td>
<td>Circular Green</td>
</tr>
<tr>
<td>DMV</td>
<td>Department of Motor Vehicles</td>
</tr>
<tr>
<td>FCR</td>
<td>Flashing Circular Red</td>
</tr>
<tr>
<td>FCY</td>
<td>Flashing Circular Yellow</td>
</tr>
<tr>
<td>FRA</td>
<td>Flashing Red Arrow</td>
</tr>
<tr>
<td>FYA</td>
<td>Flashing Yellow Arrow</td>
</tr>
<tr>
<td>GA</td>
<td>Green Arrow</td>
</tr>
<tr>
<td>MUTCD</td>
<td>Manual on Uniform Traffic Control Devices</td>
</tr>
<tr>
<td>PPLT</td>
<td>Protected/Permissive Left-Turn</td>
</tr>
<tr>
<td>RA</td>
<td>Red Arrow</td>
</tr>
<tr>
<td>YA</td>
<td>Yellow Arrow</td>
</tr>
</tbody>
</table>
1. INTRODUCTION

Left-turns at signalized intersections are a significant challenge for traffic engineers, from both a safety and operations standpoint. Completing a left-turn can be a dangerous maneuver for drivers to complete because drivers must focus on several things at one time. Prior to completing a left-turn, a driver must comprehend the meaning of the traffic signal indication, whether the oncoming traffic is far enough away and the gap is sufficient to make a safe turn, and whether there are any conflicting pedestrians trying to cross the street. The California Center for Innovative Transportation estimated that approximately 27 percent of crashes occurring at intersections are associated with left-turn movements [1]. As a result, improving safety conditions for left-turning vehicles has the potential to significantly reduce crash rates.

To improve safety for drivers turning left, a protected-only left-turn traffic signal phase can be used. However, from an operations standpoint, providing protected-only left-turns takes away time from the through movements and typically reduces the capacity of the intersection. As a result, many traffic engineers have implemented Protected/Permissive Left-Turn (PPLT) phasing as a way to create a fair balance between safety and traffic flow. In PPLT phasing, both a protected phase and a permissive phase are provided for left turns during the same signal cycle. PPLT phasing has been proven to significantly reduce levels of delay, while still providing an acceptable level of safety. As a result, the use of PPLT phasing has become very widespread across the country [2].
In the past, a wide variety of signal indications have been used for PPLT control. One reason for this is that the *Manual on Uniform Traffic Control Devices* (MUTCD) has not been specific about how PPLT phasing should be implemented. Many states have implemented a five-section signal display that features a circular green (CG) indication for the permissive left-turn phase and a green arrow (GA) for the protected left-turn phase. Use of the CG indication has the potential to create driver confusion. The reason for this is that for through vehicles, the CG indication means *Go*, but for left-turning vehicles, the CG means *Yield* to oncoming traffic before proceeding. In an effort to convey a clearer message to drivers, several agencies have attempted to use alternative indications/displays for PPLT control. Specifically, these include the use of the flashing circular red (FCR), flashing red arrow (FRA), flashing circular yellow (FCY), and flashing yellow arrow (FYA) [3].

One of the main principles of the MUTCD is that “traffic control devices should be placed and operated in a uniform and consistent manner” [4]. The National Committee on Uniform Traffic Control Devices (NCUTCD) has expressed concern about the lack of uniformity in regards to PPLT control [3]. As a result, NCHRP Project 3-54 was conducted to evaluate the various indications used for PPLT control and to make a recommendation as to which PPLT indication conveys the clearest message to drivers. NCHRP Report 493 was published as a comprehensive summary of all the projects that were completed as part of NCHRP Project 3-54.
The results from the studies completed as part of NCHRP Project 3-54 indicated that the FYA displayed higher levels of driver comprehension and lower fail-critical rates than the CG. It also provides greater flexibility in signal phasing and eliminates the yellow trap condition. The yellow trap condition exists when the CG changes to a CY for a left-turning vehicle, while the oncoming traffic still has a green signal. When this occurs, the driver turning left often thinks they must clear the intersection, and enters the intersection when it is unsafe to do so. Ultimately, NCHRP Report 493 recommended that the FYA display be included in the MUTCD as an alternative display to the CG indication for PPLT control. NCHRP Report 493 also recommended that the FYA be implemented in an exclusive signal arrangement as a four-section, all-arrow, vertical display, as shown in Figure 1-1 [3].

![Figure 1-1. FYA Four-Section Vertical Display][3]
1.1. Problem Statement

In 2006, the Federal Highway Administration issued a memorandum for interim approval allowing the use of the FYA in PPLT control [5]. The 2009 version of the MUTCD now includes the FYA as an acceptable permissive left-turn indication. Since then, the use of the FYA indication has become widespread, and is now implemented in most states throughout the country. Although the FYA has been implemented in most states, the magnitude of implementation has varied significantly [6]. A potential reason for this variation is that in order to install the FYA, a new and exclusive four-section vertical display is required. The additional cost of installing a new signal display could be deterring some agencies from implementing the FYA at more locations.

Developing a cost effective way to implement the FYA would allow agencies to implement the FYA at a quicker pace and at more locations. A potential solution for doing this is retrofitting existing signal displays with the FYA indication. The main benefit of a retrofit solution is that it would allow for quicker and cost-effective implementation of the FYA. There is little doubt that quicker implementation has benefits, as it would help to establish a uniform device for permissive left-turn control and would help to improve driver comprehension of the FYA. Another benefit of the retrofit solution is the associated cost savings. Although, the benefits of implementing a retrofit solution for the FYA seem intuitive, there have been limited research efforts that have specifically studied the impacts of the retrofit solution on driver comprehension. Additionally, it is unclear as to the impact of implementing a FYA indication in a bi-modal signal section pertaining to driver’s comprehension of the other indications.
1.2. **Research Objectives and Scope**

The objective of this research was to analyze the driver comprehension impacts of retrofitting existing signal displays with the FYA. Specifically, the following six signal indications and arrangements were evaluated:

- Three-Section Vertical: Bottom Section GA/FYA Bimodal
- Three-Section Vertical: Middle Section YA/FYA Bimodal
- Four-Section Vertical: All Arrow (Current MUTCD Standard)
- Four-Section Horizontal: All Arrow (Current MUTCD Standard)
- Five-Section Clustered: Bottom Left Section GA/FYA Bimodal
- Five-Section Clustered: Middle Left Section YA/FYA Bimodal

Driver comprehension was analyzed by conducting a computer-based evaluation at various locations across Madison, Wisconsin and Amherst, Massachusetts. Although the analysis method is described as static, flashing indications were dynamically presented within the static environment. The results from the evaluation were analyzed to determine if the location of the FYA section within any given signal arrangement has a significant impact on driver comprehension. FYA. The scope of the research was limited to two regional study sites with data collection over a three week period. Only selected signal display arrangements and indication combinations were used to limit the number of scenarios presented to subjects.
1.3. Research Methodology

1.3.1. Task 1: Literature Review

A comprehensive literature review was completed to present previous research on the FYA. The literature review contains a summary of NCHRP Report 493, summaries of research studies completed after NCHRP Report 493 was published, and summaries of before and after field studies related to the implementation of the FYA. The complete literature review can be found in Chapter 2.

1.3.2. Task 2: Data Collection

The data for this research was collected by conducting a computer-based static evaluation. Researchers for the Wisconsin Traffic and Operations Safety (TOPS) Laboratory supported this research effort by coordinating data collection efforts at various locations across Madison, Wisconsin. Data collection was primarily conducted at the University of Wisconsin-Madison campus and the Wisconsin Department of Transportation Division of Motor Vehicles (DMV) drivers’ license facilities in the Madison, WI area. Each subject was asked to complete the computer-based evaluation. The study was also conducted in Amherst, Massachusetts by researchers at the University of Massachusetts-Amherst. The evaluation recorded results onto the computer as a CSV file for data analysis. A detailed description of the evaluation and data collection method is described in Study Design Chapter 3.
1.3.3. Task 3: Analysis and Results

Data were analyzed using R and Microsoft Excel to perform the necessary statistical analysis. A series of Pearson’s chi-squared analyses were completed to identify statistically significant responses based on various variables. Plots were also created that display the 95 percent confidence intervals for each analysis. One of the main goals of the analysis was to determine if driver comprehension varied if the FYA indication occurred in the middle section compared to the bottom section of a bimodal signal display. Another main goal of the analysis was to determine if the FYA indication occurring in a bi-modal display had an impact on driver comprehension. Differences in the signal display arrangement were also analyzed for impacts on driver comprehension. Secondary goals of the analysis included tests to determine if the through indication, the presence of opposing traffic, and differences in demographics had any impacts on driver comprehension. The analysis and results are described in Chapter 4.

1.3.4. Task 4: Conclusions

The results from the statistical analysis are documented and summarized by explaining what the results indicate and how they can be used moving forward. Additionally, general observations made while conducting the data collection task are explained. Potential future research as well as the contributions made to the field of transportation engineering are included as well. The conclusions are documented in Chapter 5.
2. LITERATURE REVIEW

The Manual on Uniform Traffic Control Devices (MUTCD) identifies four modes of left-turn control that can be used at signalized intersection [4]:

- **Permissive-Only**: Left-turning vehicles must yield to oncoming traffic and pedestrians before completing the turn. This mode does not require an exclusive signal display.

- **Protected-Only**: Left-turning vehicles may go when there is a GA indication displayed. This mode does require an exclusive signal display for left-turning vehicles.

- **Protected/Permissive**: Left-turning vehicles are provided with a protected interval and permissive interval during each cycle. This mode does require an exclusive signal display for left-turning vehicles.

- **Variable**: The mode used to control left-turn movements changes throughout the day based on time of day and traffic volume. This mode requires an exclusive signal display for left-turning vehicles.

Protected-only left-turn phasing is the safest mode because it prevents left-turning vehicles from completing a left-turn while the oncoming traffic has a CG indication. The problem with protected-only left-turn phasing is that it also significantly reduces operational efficiency, because it takes time away from the through phases in order to give time to the left-turn phase. PPLT was developed to improve operational efficiency compared to protected-only phasing, as it allows left-turning vehicles to complete a left-
turn while the oncoming traffic has a CG indication. In PPLT phasing, most of the left-turning vehicles complete the turn while having a protected left-turn, so this phasing still offers some of the safety advantages of using protected left-turn control [3]. Several variations of PPLT signal indications, arrangement, and phasing have been used by traffic engineers in the past. Recently, the use of the FYA has become a commonly used indication for left-turn signal control. The following sections summarize the relevant research and literature that pertains to left-turn signal control and the use of the FYA.
2.1. Summary of Protected/Permissive Left-Turn Signal Control

NCHRP Report 493, published in 2003, identified the current MUTCD standards for PPLT control, alternative PPLT displays that have been used in the past, and summarized several research projects conducted over a seven year period as part of the NCHRP Project 3-54. The ultimate goal of this report was to identify the best traffic signal display for PPLT control.

Prior to NCHRP Report 493, the MUTCD standard for PPLT control included a solid GA indication for the protected interval and a solid CG indication for the permissive interval. In a computer-based evaluation conducted as part of the research project, it was found that the most common signal arrangements used were the five-section cluster, five-section horizontal, and five-section vertical displays, as shown in Figure 2-1. Together, these signal displays accounted for over 90 percent of all reported PPLT displays [3].

![Figure 2-1. Five-Section PPLT Signal Displays](image)
(a) Five-Section Cluster, (b) Five-Section Vertical, and (c) Five-Section Horizontal Signal Displays
Using the CG indication for the permissive left-turn signal indication has several disadvantages. The main disadvantage is that using a CG can send a mixed message to drivers. For through vehicles, the CG means that drivers can proceed cautiously since they have the right-of-way. For left-turning vehicles, the CG means drivers must yield to oncoming traffic and pedestrians prior to making the turn. The second disadvantage is that using the CG with lead-lag phasing introduces a yellow trap condition, unless special signal sections are used to prevent adjacent through traffic from seeing the left-turn signal. The yellow trap condition exists when the CG changes to a CY for a left-turning vehicle, while the oncoming traffic still has a green signal. When this occurs, the driver turning left often thinks they must clear the intersection, and enters the intersection when it is unsafe to do so. Due to the fact that the CG has these disadvantages, traffic engineers have attempted to use several alternative indications for PPLT control. These include the use of the FCR, FRA, FCY, and FYA. Special lenses and louvers have also been used in an effort to display a green signal to left-turning vehicles while displaying a red signal to through vehicles [3].

Several research tasks were completed as part of NCHRP Project 3-54, with the purpose of identifying which display is most effective for PPLT control. A wide variety of research was completed, including driver comprehension evaluations, crash data analysis, operational data analysis, and full-scale driving simulator studies. Based on the results from these projects, NCHRP Report 493 recommended that the FYA display should be included in the MUTCD as an alternative display to the CG indication for PPLT control. The four-section, all-arrow, vertical display was recommended [3].
2.2. Driver Comprehension Studies of Flashing Yellow Arrow

Since the completion of NCHRP Report 493, several driver comprehension studies related to the use of the FYA have been completed. Throughout the following sections, there are a few terms that are used to describe driver responses during driver comprehension tests. Correct Response means the driver interpreted the PPLT signal correctly. Fail-Safe Response means the driver interpreted the PPLT signal incorrectly, but did not impede on the right-of-way of the opposing traffic. Fail-Critical Response means the driver interpreted the PPLT signal incorrectly and did impeded on the right-of-way of the opposing traffic. In a real world scenario, the Fail-Critical Response would likely indicate a serious collision [7].

2.2.1. Comprehension of Flashing Yellow Arrow after Implementation

The Illinois Department of Transportation implemented the FYA signal at more than 100 intersections in 2010. Schattler et al. evaluated driver comprehension of the FYA after the implementation of the FYA signals (19). A total of 363 drivers around the Peoria area completed online evaluations in two phases. The first phase was completed five months after implementation of the FYA signals and the second phase was completed 16 months after implementation. The evaluation included seven left-turn scenarios, shown in Figure 2-2 [8].
Figure 2-2. Scenarios Evaluated in Previous Research Study Conducted to Analyze Impacts of FYA Implementation [8]

For each scenario, participants were asked if they have seen a similar signal before. Participants were also presented with the following three options to answer each scenario:

- **Go** – You have the right of way.
- **Yield** – Wait for a gap.
- **Stop** – Wait for a signal.

The results from the evaluation show that drivers had high comprehension rates for both FYA and CG left-turn indications, however, there were significantly higher incorrect “Go” responses for the CG compared to the FYA scenario. Including the
supplemental signing that alerts drivers to yield on FYA significantly improved driver comprehension. Not only was driver comprehension improved with the supplemental signing, but there were also significantly fewer fail-critical responses. Drivers understood the FYA better when the adjacent through signal was green instead of red. Also, 66% of drivers answered that the FYA is the best way to indicate that the driver must yield oncoming traffic before completing the left turn. Altogether, the results from the evaluation suggest that the FYA improves driver comprehension compared to CG, and that the supplemental sign also helps to enhance comprehension [8].

In a study completed by the Missouri Department of Transportation, an evaluation was conducted to analyze how drivers in the Creve Couer, Missouri area comprehended the FYA indication. Each participant was given a series of six questions that featured a mix of scenarios using the FYA indication and CG indication. A total of 204 participants completed the evaluation. For each question, the participant could choose to answer Go, Yield, or Stop [9].

The results showed that the five-section clustered display with the CG indication was the best understood signal, as 94% of the participants answered that question correctly. The CG indication was only analyzed with the CG through displayed simultaneously. In addition, the five-section clustered display was accompanied with a supplemental sign saying “LEFT TURN YIELD ON GREEN [GREEN CIRCLE]”. Among all the questions with the FYA indication displayed, participants were correct 72.4 % of the time. When the FYA indication was displayed with a simultaneous CG through indication, participants were correct 79.5% of the time. The FYA indications were accompanied with a different supplemental sign saying “LEFT TURN SIGNAL”.
The researchers concluded that the most concerning response was how often participants answered *Go* when the FYA was displayed, creating potentially dangerous situations. Also, people who had previously seen the FYA answered correctly more than those who has not. The researchers recommended that the Missouri DOT conduct a public information campaign to inform the public about what to do when they see the FYA indication [9].

Altogether, the study did not test for a true comparison between the FYA and CG, since the background scenarios varied in each scenario. Only 53 percent of respondents had observed a FYA prior to completing the study, but approximately 80 percent responded to the FYA correctly. As a result, this indicates that a significant number of drivers understood the FYA correctly without any prior training.

2.2.2. Comprehension of Other Flashing Yellow Arrow Arrangements

As mentioned earlier, NCHRP Report 493 recommended that the FYA be implemented using an exclusive four-section vertical signal display. However, several agencies have previously installed the five-section clustered signal arrangement for use in PPLT phasing in order to meet the MUTCD requirement of having two through indications [4]. Since there are very few four-section signal displays already in use in a non-shared application, the idea of retrofitting the five-section clustered display with the FYA indication in a shared application has been proposed. This would make it easier and less expensive for agencies to implement the FYA until they are capable of installing a four-section signal display. A potential drawback from this solution is that in order to meet MUTCD requirements, simultaneous indications would need to be displayed on the
five-section clustered display. In simpler terms, when the FYA indication would be displayed for left-turning vehicles, the CG, CY, or CR would also need to be displayed for through vehicles. The simultaneous indications could have a negative impact on driver comprehension [7].

Knodler, et al. conducted research to evaluate the impact of simultaneous indications on driver comprehension. A driving simulator experiment was completed as well as a follow-up and independent driver comprehension evaluation. A total of seven variations of the five-section clustered display were evaluated, as shown in Figure 2-3 [7].

![Figure 2-3. Scenarios Evaluated in Previous Research Study Conducted to Analyze Impacts of Simultaneous Indications [7]](image-url)
A total of 54 people participated in the driving simulator evaluation. Each person participated in two modules that consisted of 14 intersections. Eight of those intersections featured permissive left-turns. Each PPLT signal display included opposing traffic, and the experiment included intersections that did not feature PPLT to ensure variability and counterbalance the objective of the experiment [7].

Every driver that completed the simulator study also completed the evaluation, in what was called a follow-up static evaluation. An additional 210 participants were also recruited to complete the evaluation, in what was called an independent static evaluation. Each participant was shown 29 scenarios, including the seven permissive signals shown in Figure 2-3. For each scenario, the participant was asked what they would do if they wanted to turn left. The following answers were available for selection [7]:

- Go because you have the right of way.
- Yield and wait for a gap.
- Stop and then wait for a gap.
- Stop and wait for a signal.

The results showed that the retrofit FYA display improved driver comprehension compared the existing CG display. In the follow-up driver comprehension evaluation, 89% responded with Yield to the five-section clustered signal display with FYA and CG indications simultaneously displayed. This compares to only 65% who responded with Yield when just the CG indication was displayed. This difference was found to be statistically significant. The driving simulator experiment resulted in no significant
differences between the percentages of Yield responses. Overall, the researchers concluded that the use of the FYA in the five-section clustered signal display does not reduce driver comprehension. It is important to note that previous research has indicated that there are human factors issues associated with the use of simultaneous indications, and that the use of the FYA in the five-section clustered display only be used in the interim as agencies upgrade to the four-section vertical display [7, 10].

In another study, Noyce and Smith evaluated comprehension of the FYA indication in various arrangements of five-section signal displays. A driving simulator study was completed in addition to a computer-based evaluation. A total of 15 scenarios were analyzed, as shown in Figure 2-4. The CG, flashing CY (FCY) FYA, flashing CR (FCR), and flashing yellow red were evaluated in the study [11].

Figure 2-4. Scenarios Evaluated in Previous Research Study Conducted to Analyze Impacts of Various FYA Arrangements [11]
The driving simulation included a total of 24 intersections, with 10 of the intersections involving permissive left-turns. Each participant completed the simulation a total of four times, with the background scene and order of movements changing each time. A total of 991 responses were evaluated in the driving simulator. For the computer-based evaluation, drivers were presented with images of each of the 15 scenarios. For each image they were given the following answers to choose from [11]:

- Go, you have the right-of-way.
- Yield, go if an acceptable gap in opposing traffic allows.
- Stop, then go if an acceptable gap in opposing traffic allows.
- Stop, you do not have the right-of-way.

The results show that the CG, FYA, and FCY were best understood. Indications using a flashing red signal were not well comprehended. The five-section horizontal display using the FCY indication was the best understood signal. The CG indication had a significantly lower comprehension rate in the evaluation compared to the driving simulator. The researchers concluded that this indicated that drivers likely do not understand the true meaning of the CG, and use other visual cues to determine the correct response at an intersection. It was also concluded that using a driving simulator is an effective way to analyze driver comprehension of traffic signals [11].
2.2.3. Comprehension of Flashing Yellow Arrow with Separate Left-Turn Lanes

There are several instances where intersections feature wide medians, where the left-turn lanes are separated from the adjacent through lanes. This creates a scenario where left-turning vehicles do not see the signals for the through vehicles, and as a result, can only see the signal associated with the left-turn lane. In these instances, several agencies have tried using the FRA instead of the CG.

Knodler, et al. conducted research to evaluate the effectiveness of the FYA compared to the FRA at intersections with separated left-turn lanes. The experiment include a driving simulator study and a driver comprehension evaluation. Four permissive signal displays, shown in Figure 2-5, were evaluated for both parts of the experiment. The research was conducted in Massachusetts and Wisconsin. At the time of the research, both of these states used the CG for PPLT phasing, and only used protected left-turn phasing at wide intersections. As a result, it was assumed that the participants were unfamiliar with flashing arrows as an alternative to the CG for permissive left-turns [12].

![Figure 2-5. Scenarios Evaluated in Previous Research Study Conducted to Analyze Impacts of FYA at Intersections with Wide Medians [12]](image-url)
A total of 54 participants were used for the driving simulator study. Each participant was exposed to a wide range of phasing concepts, including the four permissive signals shown in Figure 2-5. The purpose of providing a wide range of phasing concepts was to provide more variability in the experiment and prevent participants from identifying the nature of the evaluation [12].

Every driver that completed the simulator study, also completed the evaluation, in what was called a follow-up static evaluation. An additional 100 participants were also recruited to complete the evaluation, in what was called an independent static evaluation. Each participant was shown 29 scenarios, including the four permissive signals shown in Figure 2-5. For each scenario, the participant was asked what they would do if they wanted to turn left. The following answers were available for selection [12]:

- Go because you have the right of way
- Yield and wait for a gap
- Stop and then wait for a gap
- Stop and wait for a signal

The results for the driving simulator experiment showed that the two scenarios using the FYA resulted in a significantly higher percentage of *Yield* responses at approximately 70 percent. The two FRA scenarios resulted in a significantly higher percentage of *Stop and Wait* responses. The FYA scenarios did have more fail-critical, *Go*, responses than the FRA scenarios. It is important to note that all but one of the *Go* responses for the FYA scenario occurred on the first observation of the FYA. The follow-
up static evaluation resulted in correct responses ranging from 91% to 93%. Once again, the FYA scenarios did have more fail-critical, *Go*, responses than the FRA scenarios. In the independent static evaluation provided results similar to the driving simulation and follow-up evaluation. The FYA scenarios had a *Yield* response rate of 62%, and it once again provided more fail-critical responses than the FRA scenarios. Ultimately, it was recommended that the FYA not be installed at wide intersection until the use of the FYA indication becomes more widespread [12].

### 2.2.4. Impact of Flashing Yellow Arrow on CG Indication

Since the FYA will be implemented over a long period of time, there will be two permissive left-turn indications in use for the next several years. Specifically, both the FYA and the CG should portray the same *Yield* meaning to left-turning vehicles. There are some concerns that as drivers become more familiar with the FYA, that they will begin to develop a different understanding of the CG. In the worst case scenario, drivers would begin to comprehend the CG as a *Go* instead of a *Yield*, creating a fail-critical situation [13].

Knodler, et al. conducted research to evaluate the impact that implementation of the FYA has on driver comprehension of the CG indication. A static driver comprehension evaluation and a driving simulator experiment were completed. A total of seven scenarios were used, with five featuring the FYA and two featuring the CG [13].

A total of 100 people completed the evaluation. Prior to starting the evaluation, each participant was provided with a tutorial informing them what to do when they see a FYA indication. The tutorial explained that they should yield to oncoming traffic. The tutorial also clearly explained that they do not have the right-of-way and that they do not
need to stop and wait for another signal. Each participant was shown the seven scenarios being evaluated. For each scenario, the participant was asked what they would do if they wanted to turn left. The following answers were available for selection [13]:

- Go, you have the right of way
- Yield, then go if a gap in the opposing traffic exists
- Stop, then go if a gap in the opposing traffic exists
- Stop and wait for the appropriate signal

A total of 25 participants were used for the driving simulator study. All participants also completed the static evaluation. Each participant encountered 14 intersections and completed seven left-turns. The left-turns included a mix of FYA, CG, and a protected GA [13].

The results from this study were compared to the results of previous studies to see how driver comprehension of the CG indication changes after they have a better understanding of the FYA indication. A chi-squared analysis was used to complete the analysis and compare the results [13].

The results from the driving simulator experiment showed that driver comprehension of the CG indication before FYA exposure did not change much from driver comprehension of the CG indication after FYA exposure. The static evaluation also showed similar results. In the follow-up evaluation, drivers exposed to the FYA actually answered *Yield* when the CG indication was displayed more often than drivers who had not been exposed to the FYA. The researchers concluded that implementing the FYA should not impact driver comprehension of the CG indication [13].
2.2.5. Impact of Flashing Yellow Arrow on Solid Yellow Indication

Another concern of implementing the FYA is how it impacts driver comprehension of the solid yellow indication. Since the FYA introduces the use of the yellow indication to indicate something other than the termination of the phase, there is some concern that drivers might have a difficult time understanding when the FYA phase is being terminated. There is also some concern that driver comprehension of the CY indication might change [14].

Knodler, et al. conducted research to evaluate the impact of the FYA indication on the solid yellow arrow (YA) indication. To do this, a static, computer-based evaluation with a total of 212 participants was conducted. To examine the effects of the FYA indication, participants first answered questions regarding their understanding of the SYA indication without receiving any prior information about FYA. Participants were then exposed to the FYA and its meaning. Following this, another evaluation was completed regarding driver comprehension of the SYA indication [14].

The results from the evaluation show that over half of the participants changed their responses to the SYA indication after being exposed to the FYA indication. Despite the large difference in responses, it was concluded that the differences in the responses did not indicate that comprehension of the SYA is reduced after drivers are exposed to the FYA [14].

In another study completed by Knodler and Fisher, an evaluation was conducted to establish a baseline understanding of how drivers comprehend the solid yellow indication. The purpose of this study was to develop a foundation of statistics that can be used to analyze future impacts of the FYA indication on driver comprehension of the
solid yellow indication. Some of the results from this evaluation were surprising, as it appears that drivers already do not comprehend the solid yellow indication extremely well. Only 80% of participants answered that the red light is coming next and that the preceding movement is ending when the solid yellow circle was displayed. When presented with a SYA indication and a CG indication, only 58% of participants selected that the CG indication would be the next display. Also, only about half of the participants correctly identified the MUTCD recommended length of the CY phase. These results seem to indicate that drivers do not really understand the meaning of the solid yellow indication and do not have a great grasp of how traffic engineers use the five-section clustered signal display to sequence signal indications [15]

2.2.6. Pedestrian Safety at Flashing Yellow Arrow Intersections

Pedestrian phases are commonly provided when the parallel through traffic has a green indication. When permissive left-turns are included in the signal phasing, a potential conflict is developed between the left-turning vehicles and the pedestrians trying to cross the street. In these cases, the pedestrian has the right-of-way to cross the street. A couple studies have been completed to analyze both pedestrian and driver comprehension of the FYA.

Knodler, et al. researched both pedestrian and driver comprehension of the FYA by conducting a driving simulator experiment, an evaluation for driver comprehension, and an evaluation for pedestrian evaluation [16].

The driving simulator experiment was completed using the full-scale driving simulator located at the University of Massachusetts-Amherst. Five permissive signal scenarios were used for the experiment. Three of the scenarios used the FYA and two of
the scenarios used the CG. A total of 36 drivers completed the simulation. Each driver completed two modules. In the first module, pedestrians were present but never entered the crosswalk. In the second module, pedestrians did enter the crosswalk [16].

For the driver comprehension evaluation, a total of 139 participants completed the study. Each participant completed 25 scenarios. Of the 25 scenarios, nine included permissive left-turn indications. Seven of the permissive indications used the FYA and two used the CG. The pedestrian presence varied between no pedestrian, pedestrian waiting to cross, and a visually impaired pedestrian waiting to cross with dog guide. For each scenario, participants were given the following answers to choose from [16]:

- Go, you have the right of way.
- Yield, then go.
- Stop first, then go.
- Stop, wait for signal.

If the participant answered Yield, then go, they were also asked an additional question about whom they must yield to, with the following available answers [16]:

- Opposing Vehicles.
- Pedestrians.
- Cross-Street Vehicles.
- None of the Above.
For the pedestrian comprehension evaluation, participants were provided with various signalization alternatives. One hundred participants completed the study. For each scenario, the participant was asked if they were allowed to enter the crosswalk for the given traffic signal. The available answers were Yes, No, and Not Sure [16].

Overall, there was a higher percentage of fail-critical responses than correct responses for the driving simulator study. The results from the driver comprehension evaluation showed that driver comprehension was higher in the static evaluation compared to the simulator study. Overall, the FYA performed better than the CG, and had fewer incorrect Go responses. The majority of participants in the pedestrian evaluation did not understand correct crossing procedures. When no crossing signal was provided, pedestrians were able to correctly identify crossing opportunities more often when the CG was used compared to the FYA. A possible reason for this is that the pedestrians might not have seen the FYA before. Altogether, this study identified several concerns associated with driver comprehension in terms of yielding to pedestrians. The FYA did not reduce driver comprehension compared to the CG, and with time, the researchers believe the FYA will become more effective [16].

Hurwitz and Monsere researched pedestrian safety at intersections with the FYA by using a driving simulator located at Oregon State University. The study varied the number of pedestrians, the number of opposing vehicles, and the FYA signal configuration. ASL Mobile Eye-XG equipment was used to track where the drivers were looking during the study. Each subject was asked to complete a total of six left-turns [17].

The results from this study showed that as pedestrian activity increased, drivers began to focus on the pedestrians more. Drivers focused on pedestrians less as the
number of opposing vehicles increased. Overall, between four and seven percent of the drivers did not focus on pedestrians at all. There were not any significant differences between the use of the three-section and four-section signal configuration [17].
2.3. Field Studies of Flashing Yellow Arrow

After NCHRP Report 493 recommended the use of the FYA for PPLT control, several agencies began implementing the FYA indication. Noyce, et al. conducted a research study to examine the safety effectiveness of the FYA indication in the field, as part of NCHRP Project 20-7, Task 222. To complete this study, the researchers compiled information about all the known FYA installations throughout the country, and analyzed the crash data of each intersection. The results showed that implementing the FYA improved safety at intersections already using PPLT phasing. Crash rates did increase at intersections that had been converted from protected-only to PPLT with the FYA indication. Overall, the researchers concluded that the FYA improves safety compared to the CG indication [18].

The following sections summarize a few of the field studies that have been completed by various agencies throughout the country.

2.3.1. Peoria, Illinois

As mentioned earlier, the Illinois Department of Transportation implemented the FYA signal at more than 100 intersections in 2010. Schattler et al. conducted an operational and safety evaluation by performing a before and after study of 16 approaches in the Peoria, Illinois area. For all 16 approaches, the signal operations did not change, meaning that the only change that occurred was that the CG was replaced with the FYA. A total of 128 hours of data collected with 50% of the hours being before and 50% of the hours being after the installation of FYA. The following data was collected for each of the approaches [8]:
• Size of accepted critical gap for left-turning vehicles.
• Left-turning vehicles that entered late in the solid yellow interval.
• Left-turning vehicles that entered at the beginning of the red interval.
• Left-turn traffic conflicts.

The results from the before and after field study show that there are no significant differences between the accepted critical gap for the FYA compared to the CG. Red and yellow light running appears to be minimally affected by conversion to the FYA. Altogether, the researchers concluded that there are not any negative impacts on traffic operations when using the FYA [8].

2.3.2. St. Louis, Missouri

Lin, et al. conducted a field study to analyze driver reaction to the FYA indication at one approach of an intersection located in St. Louis, Missouri. Prior to this study, most studies involving driver comprehension of the FYA indication involved asking participants to complete a static, computer-based evaluation. The idea behind this study was to develop a new method to observe how drivers comprehend the FYA indication [19].

The research was completed by using a video observation method. To perform this method, the researchers categorized driver reactions to the various signal indications used in PPLT signal control. These reactions were then classified as correct, fail-safe, or fail-critical. The researchers also calculated a safe left-turn gap based on speed and distance to analyze whether drivers were entering the intersection with a large enough gap when the FYA indication was displayed. The results showed that 89.9% of drivers
were classified with a correct response, 5.2% of drivers were classified with a fail-safe response, and 4.9% of drivers were classified with a fail-critical response. These results were not compared to any results using the CG indication. The researchers did conclude that using the video observation method is more effective than using computer-based evaluations, as it captures real-world driver responses [19].

2.3.3. Charlotte, North Carolina

Pulugurtha, et al. conducted a before and after evaluation of six intersections that were changed from using a CG indication to a FYA indication for PPLT control. The study took place in Charlotte, North Carolina. The EB method was used to evaluate the impact of the FYA indication. This method involves analyzing the actual number of crashes after the installation of the FYA and the estimated number of crashes had the FYA not been installed [20].

The results from the study showed that the actual number of crashes was lower than the estimated number of crashes at five of the six study intersections. Three of the intersections had a crash reduction of almost 50%. Altogether, the FYA did improve safety at the majority of the intersections studied, but due to the low sample size, it was not possible to determine that installing FYA will effectively improve safety at all signalized intersections. Further studies should be completed to analyze the intersection and crash characteristics, such as phase timing and crash types [20].

2.3.4. Jackson County, Oregon

A study was also completed in Jackson County Oregon regarding the implementation of the FYA indication throughout the county. Several four-section and three-section vertical displays implementing the FYA indication were installed at
intersections throughout the county. Niemeyer completed the study by analyzing crash
data, community feedback, and by performing a cost benefit analysis [21].

A total of seven intersections were analyzed for the study. Six of the intersections
were changed from protected-only phasing to PPLT phasing using the FYA. At these
intersections, a three-section vertical display was used instead of a four-section display in
an effort to reduce the cost of implementing the FYA. The FYA was combined with the
SYA in the middle section of the display. One of the intersections was already used PPLT
phasing with the five-section clustered display. This display was replaced with a four-
section vertical display [21].

The results from the study show that the FYA significantly reduced crashes at the
intersection that used PPLT phasing prior to implementing the FYA. The six intersections
that were changed from protected-only phasing did experience an increased crash rate,
but also experienced significant reductions in delay. The benefit-cost ratio of
implementing FYA at these intersections was well above 1 for every intersection. This
confirmed the idea that PPLT phasing can help to improve traffic flow while still
maintaining a certain level of safety [21].

Using the three-section vertical display for the FYA has been somewhat
controversial among traffic engineers. Several engineers are worried that combining the
FYA with the SYA could have an impact on driver comprehension of the yellow change
interval. The results from this study showed that no crashes were related to the left-turn
clearance phase and that there was no negative feedback regarding the transition from the
FYA indication to the SYA indication. Niemeyer concluded that further studies should be
completed regarding the use of the three-section vertical display [21].
2.4. Summary of Literature Review

Several studies have analyzed driver comprehension of the FYA indication. The main conclusions of these studies are shown below:

- Compared to the CG indication, the FYA indication shows a higher level of driver comprehension and lower fail-critical rates.
- The four-section vertical display is the recommended signal arrangement for the FYA indication.
- Use of the FYA in the five-section clustered signal display has potential to be used in the interim, as agencies upgrade to the four-section vertical display.
- The FYA should not be installed at intersections with wide medians until the use of the FYA indication becomes more widespread.
- The FYA does not seem to reduce comprehension of the CG indication.
- The FYA does not seem to reduce comprehension of the SYA indication. Studies did show that many drivers do not seem to understand the meaning of the solid yellow indication in general though.
- Field studies show that in general, implementation of the FYA results in lower crash rates and improved traffic flow.
3. STUDY DESIGN

3.1. Evaluation Development

Data for this research was collected by conducting a computer-based static evaluation. Researchers for the Wisconsin Traffic and Operations Safety (TOPS) Laboratory supported the data collection effort set-up tables at various locations across Madison, Wisconsin and asked people passing by to complete the evaluation. The set-up consisted of two laptops that ran the evaluation. In addition, candy was provided to participants as a reward for completing the evaluation. In Madison, evaluations were completed at Union South and the Madison DMV drivers’ licensee facilities. Union South was selected as a location because of its high student population, and the fact that several people pass through the building each day. The DMV was selected because people tend to have a lot of downtime while waiting for service. The study was also conducted in a similar manner in Amherst, Massachusetts by researchers at the University of Massachusetts-Amherst.

Prior to beginning the evaluation, participants were asked to read a disclaimer and agree to complete the evaluation. Upon agreeing to complete the evaluation, the participants were asked to answer demographic questions regarding their gender, age, and driving experience. The available responses for age and driving experience were grouped into ranges, as shown in Table 3-1. The purpose of asking these demographic questions was that it provides the opportunity to analyze those variables with respect to driver comprehension.
Table 3-1. Available Responses for Demographic Questions

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age</th>
<th>Driving Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>18-24</td>
<td>&lt;5 Years</td>
</tr>
<tr>
<td>Female</td>
<td>25-34</td>
<td>5-9 Years</td>
</tr>
<tr>
<td></td>
<td>35-44</td>
<td>&gt;10 Years</td>
</tr>
<tr>
<td></td>
<td>45-54</td>
<td></td>
</tr>
<tr>
<td></td>
<td>55-64</td>
<td></td>
</tr>
<tr>
<td></td>
<td>65-74</td>
<td></td>
</tr>
<tr>
<td></td>
<td>75+</td>
<td></td>
</tr>
</tbody>
</table>

Six different signal arrangements were evaluated, as shown in Figure 3-1. All of these configurations featured different arrangements of the FYA display. In the three-section display, the flashing yellow was located as a bimodal indication in the bottom section or middle section, and combined with the GA or YA, respectively. The current MUTCD standard four-section vertical display was included as the baseline arrangement for the study. Additionally, a four-section horizontal display was evaluated. In the five-section clustered display the FYA was included as a bimodal indication and was displayed in either the bottom left (bimodal with GA) or middle left section (bimodal with YA). Additionally, the five-section clustered display involved scenarios that displayed a FYA with a simultaneous indication and scenarios that displayed a FYA without a simultaneous indication.
In addition to the configurations being evaluated, other signal displays that featured a RA, YA, or GA were included in the evaluation to ensure that there was variability in the study. Also, the presence of opposing traffic was varied between present and not present throughout the study. A complete list of scenarios, with figures, can be seen in Appendix 6.2.

Altogether, the scenarios were divided into three categories: Experimental, Baseline, and Control. The experimental and baseline scenarios include all the configurations shown in Figure 3-1. Experimental scenarios feature a bimodal FYA, while Baseline scenarios feature a four-section signal display with a separate section for the FYA. The Control scenarios consisted of signals featuring a RA, YA, or GA. These
scenarios were added to create variability in the study. They also provide a measure of data quality assurance, as these scenarios should feature a high rate of correct response.

Each participant was presented with 15 scenarios. Scenarios were programmed to be randomly selected, therefore, each subject observed a different set and different order of scenarios. The only caveat to that is if one of the scenarios that involved a bimodal arrangement of the FYA was displayed, the corresponding bimodal arrangement of the FYA was displayed next. For example, if a three-section vertical display with the FYA displayed in the bottom section was shown, the next question would feature a three-section vertical display with the FYA displayed in the middle section. This can be seen in greater detail in Appendix 6.2, as scenarios with bimodal arrangements are named with an “a” and “b” designation.

For every question, the participant was asked “If you want to turn left and see the signal indications shown below, you are...” with the following answers to choose from:

- not allowed to turn left, stop.
- allowed to turn left; however, you must wait for a large enough opening in the oncoming traffic before doing so, yield.
- allowed to turn left since the oncoming traffic must stop, go.
- not sure whether or not a left-turn is allowed.
Upon beginning the evaluation, the participant first encountered a practice question, shown in Figure 3-2. The purpose of the practice question was to give the participant a chance to become familiar with the type of question being asked. The practice scenario is shown with opposing traffic present.

Figure 3-2. Practice Question Used in Evaluation
An example of an actual question featuring the FYA indication in a five-section clustered display is shown in Figure 3-3. The YA shown in the figure was dynamically flashing during when displayed on the computer. This example is shown without opposing traffic. The background image that accompanied the traffic signal included an actual intersection that provided the participant with the perspective that they were located in a separate left-turn bay of the intersection. Screenshots of the all the screens that a participant encountered during the evaluation can be seen in Appendix 6.1.

![Figure 3-3. Example FYA Question Used in Evaluation](image)

**Figure 3-3. Example FYA Question Used in Evaluation**
3.2. Evaluation Response Collection

The evaluation was completed on laptop computers, so the responses were recorded directly onto the computer as a CSV file. Table 3-2 shows an example of the unedited data output. Data were compiled into one Microsoft Excel workbook for analysis. Microsoft Excel and R were both used to complete the statistical analysis. The following items were included in the raw data:

- Gender of Participant
- Age of Participant
- Driving Experience of Participant
- Scenario Number
- Question Response Time
- Selected Answer

Table 3-2. Example of Raw Evaluation Data

<table>
<thead>
<tr>
<th>TimeStamp</th>
<th>AgeGroup</th>
<th>Gender</th>
<th>DrivingExperience</th>
<th>TimeToComplete</th>
<th>Attempts</th>
<th>QuestionPosition</th>
<th>QuestionName</th>
<th>ImageName</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>23-10-2013 8</td>
<td>5 F</td>
<td>3</td>
<td>6.203</td>
<td>1</td>
<td>1 9b</td>
<td>/g_exp/9b.gif</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23-10-2013 8</td>
<td>5 F</td>
<td>3</td>
<td>4.116</td>
<td>1</td>
<td>2 29</td>
<td>/g_1/29.gif</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23-10-2013 8</td>
<td>5 F</td>
<td>3</td>
<td>6.892</td>
<td>1</td>
<td>3 43b</td>
<td>/g_exp/43b.g</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23-10-2013 8</td>
<td>5 F</td>
<td>3</td>
<td>4.065</td>
<td>1</td>
<td>4 60b</td>
<td>/g_exp/60b.g</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23-10-2013 8</td>
<td>5 F</td>
<td>3</td>
<td>6.057</td>
<td>1</td>
<td>5 57b</td>
<td>/g_exp/57b.g</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. ANALYSIS AND RESULTS

4.1. Study Demographics

A total of 336 participants completed the evaluation in Wisconsin, and a total of 168 participants completed the evaluation in Massachusetts. This resulted in a combined total of 447 participants. A total of 8,948 scenarios received responses. A bimodal FYA indication was featured in 5,723 of the scenarios evaluated.

Three demographic questions were asked in the evaluation. Specifically, participants were asked to provide information regarding their gender, age, and driving experience. A summary of the demographics for the evaluation is shown in Table 4-1. The proportion of respondents was weighted towards the younger age groups due to the location of the data collection sites being on a college campus.

Table 4-1. Summary of Demographic Information

<table>
<thead>
<tr>
<th>Category</th>
<th>Level</th>
<th>Wisconsin Total</th>
<th>Wisconsin Percent</th>
<th>Massachusetts Total</th>
<th>Massachusetts Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
<td>178</td>
<td>53.0</td>
<td>102</td>
<td>60.7</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>158</td>
<td>47.0</td>
<td>66</td>
<td>39.3</td>
</tr>
<tr>
<td>Age</td>
<td>18-24</td>
<td>146</td>
<td>43.5</td>
<td>122</td>
<td>72.6</td>
</tr>
<tr>
<td></td>
<td>25-34</td>
<td>55</td>
<td>16.4</td>
<td>9</td>
<td>5.4</td>
</tr>
<tr>
<td></td>
<td>35-44</td>
<td>24</td>
<td>7.1</td>
<td>3</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>45-54</td>
<td>41</td>
<td>12.2</td>
<td>13</td>
<td>7.7</td>
</tr>
<tr>
<td></td>
<td>55-64</td>
<td>37</td>
<td>11.0</td>
<td>15</td>
<td>8.9</td>
</tr>
<tr>
<td></td>
<td>65-74</td>
<td>19</td>
<td>5.7</td>
<td>6</td>
<td>3.6</td>
</tr>
<tr>
<td></td>
<td>75+</td>
<td>14</td>
<td>4.2</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Driving Experience</td>
<td>0-5</td>
<td>108</td>
<td>32.1</td>
<td>98</td>
<td>58.3</td>
</tr>
<tr>
<td></td>
<td>5-10</td>
<td>64</td>
<td>19.0</td>
<td>28</td>
<td>16.7</td>
</tr>
<tr>
<td></td>
<td>10+</td>
<td>164</td>
<td>48.8</td>
<td>42</td>
<td>25.0</td>
</tr>
</tbody>
</table>
4.2. **Initial Summary of Results**

4.2.1. **Summary of Results from Control Scenarios**

Overall, the control scenarios featured a high rate of correct responses. Previous literature has identified a correct response rate of at least 85 percent to represent high levels of driver comprehension [3].

Scenarios that featured a GA for the left-turn indication experienced a correct (Go) response rate of 88.4 percent. Almost all of the incorrect responses for scenarios that featured a GA were Yield responses. The Yield response could be considered a correct response, since the GA does require drivers to yield to other road users lawfully in the intersection [4]. If Yield responses are considered correct, the correct response rate for these scenarios is over 99 percent. Scenarios that featured a red arrow (RA) for the left-turn indication experienced a correct (Stop) response rate of 95.6 percent. Scenarios that featured a YA for the left-turn indication experienced a wide variety of responses. Response rates were 46.6 percent Yield, 31.6 percent Stop, 16.4 percent Go, and 5.3 percent IDK. One potential reason as to why these scenarios featured such a wide variety of responses is that driver response to a YA varies largely based on the location of the vehicle when the indication changes to yellow. Also, drivers are used to seeing the YA in a transition from green to red. Since the experiment involved a static display, this could also be a potential cause of confusion. Additionally, the solid YA has inherently been an indication in which the actually meaning is unclear.

Altogether, the high levels of correct responses for the scenarios featuring a GA or RA indicates that participants correctly understood the questions being asked in the evaluation. This is important, as it initially validates that the experimental scenarios can
be used to conduct an analysis of this type. A comprehensive table of results for every scenario can be found in Appendix 6.2

4.2.2. Summary of Results from Baseline and Experimental Scenarios

The baseline and experimental scenarios experienced an overall correct response rate of 74.6 percent. Table 4-2 below displays percentages of correct responses separated by signal display and the location of the FYA. The results show that scenarios featuring the FYA in the bottom section had a slightly higher rate of correct responses than scenarios featuring the FYA in the middle section. A statistical analysis was completed in Section 4.4 to examine if there were any differences that were statistically significant. Due to the large number of scenarios evaluated, detailed responses for every scenario are displayed in Appendix 6.2.

Table 4-2. Summary of Results based on Display and FYA Section

<table>
<thead>
<tr>
<th>Display</th>
<th>Section for FYA Indication</th>
<th>Wisconsin Correct</th>
<th>Wisconsin Fail Critical</th>
<th>Massachusetts Correct</th>
<th>Massachusetts Fail Critical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four-Section Vertical</td>
<td>Separate</td>
<td>76.9%</td>
<td>7.5%</td>
<td>73.2%</td>
<td>12.1%</td>
</tr>
<tr>
<td>Four-Section Horizontal</td>
<td>Separate</td>
<td>79.2%</td>
<td>5.6%</td>
<td>69.5%</td>
<td>11.4%</td>
</tr>
<tr>
<td>Three-Section Vertical</td>
<td>Middle</td>
<td>77.1%</td>
<td>6.5%</td>
<td>68.0%</td>
<td>8.8%</td>
</tr>
<tr>
<td></td>
<td>Bottom</td>
<td>80.5%</td>
<td>6.7%</td>
<td>70.4%</td>
<td>9.9%</td>
</tr>
<tr>
<td>Five-Section Clustered</td>
<td>Middle</td>
<td>79.1%</td>
<td>7.3%</td>
<td>73.9%</td>
<td>12.0%</td>
</tr>
<tr>
<td></td>
<td>Bottom</td>
<td>78.5%</td>
<td>6.8%</td>
<td>76.2%</td>
<td>8.5%</td>
</tr>
<tr>
<td>Five-Section Clustered</td>
<td>Middle</td>
<td>76.0%</td>
<td>5.4%</td>
<td>62.0%</td>
<td>12.7%</td>
</tr>
<tr>
<td></td>
<td>Bottom</td>
<td>75.4%</td>
<td>6.3%</td>
<td>63.3%</td>
<td>11.4%</td>
</tr>
</tbody>
</table>
4.3. **Statistical Analysis**

A chi-squared test was completed to compare the proportion of correct responses from the Wisconsin data to the proportion of correct responses from the Massachusetts data. The results from this analysis showed that the two datasets are significantly different, as Wisconsin participants had a significantly higher rate of correct responses. As a result, these datasets were kept separate for the statistical analysis.

A series of Pearson’s chi-squared analyses were completed to identify statistically significant responses based on various variables. This was completed by comparing the differences in correct response rates for various sets of scenarios and using a right-tailed p-value of less than 0.05 to indicate differences as significant. A p-value of less than 0.05 was used because that has been the standard used in previous driver comprehension studies related to PPLT signal displays. The Pearson’s chi-squared test was used because it tests whether two variables are independent of each other. Throughout the statistical analysis, p-values are presented with a format, as shown in Table 4-3 to help distinguish significance.

<table>
<thead>
<tr>
<th>Significance</th>
<th>P Value</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly Significant</td>
<td>&lt; 0.001</td>
<td>0.0000</td>
</tr>
<tr>
<td>Significant</td>
<td>&lt; 0.050</td>
<td>0.0250</td>
</tr>
<tr>
<td>Not Significant</td>
<td>≥ 0.050</td>
<td>0.5000</td>
</tr>
</tbody>
</table>

Table 4-3. Formatting Associated with P Values
Plots were also created that display the 95 percent confidence intervals. These confidence intervals were calculated using the Wilson score interval [22]. In addition to completing several chi-squared analyses and creating plots with confidence intervals, the average response times for each analysis are also presented. The purpose of studying response time is that lower response times indicate a more confident response and could potentially correlate to higher driver comprehension.
4.3.1. **Flashing Yellow Arrow Location Comparisons**

This analysis compared all scenarios featuring the FYA indication in the middle section to all scenarios featuring the FYA indication in the bottom section, regardless of all other variables. Two chi-squared analyses were completed for each state. The first one examined for differences between the percentage of correct responses, while the second examined for differences between the percentage of fail-critical responses.

In Wisconsin, scenarios involving a FYA indication in the middle section had a correct response rate of 77.4 percent, while scenarios involving a FYA indication in the bottom section had a correct response rate of 78.1 percent. In Massachusetts, the correct response rates were 68.1 percent and 70.0 percent respectively. The chi-squared analysis showed that neither of these differences were statistically significant. There were also no differences in the percentage of fail-critical responses. The results from this analysis are shown in Table 4-4.

**Table 4-4. Chi-Squared Analysis for FYA Location Comparisons**

<table>
<thead>
<tr>
<th>FYA Section</th>
<th>Wisconsin (%)</th>
<th>P Value</th>
<th>Massachusetts (%)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle</td>
<td>77.4</td>
<td></td>
<td>68.1</td>
<td></td>
</tr>
<tr>
<td>Bottom</td>
<td>78.1</td>
<td>0.6170</td>
<td>70.0</td>
<td>0.3421</td>
</tr>
</tbody>
</table>

*Percentage of Correct (Yield) responses

<table>
<thead>
<tr>
<th>FYA Section</th>
<th>Wisconsin (%)</th>
<th>P Value</th>
<th>Massachusetts (%)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle</td>
<td>6.4</td>
<td>0.8125</td>
<td>11.1</td>
<td>0.3677</td>
</tr>
<tr>
<td>Bottom</td>
<td>6.6</td>
<td></td>
<td>9.9</td>
<td></td>
</tr>
</tbody>
</table>

**Percentage of Fail-Critical (Go) responses
An analysis was also completed to determine the average response times based on the location of the FYA. In both states, the average response time was lowest for the scenarios featuring the FYA indication in the middle section. It is interesting to note that the lower response time corresponds with the higher percentage of correct responses for the scenarios featuring the FYA indication in the bottom section. The average response times are shown in Table 4-5.

**Table 4-5. Average Response Time based on FYA Location**

<table>
<thead>
<tr>
<th>FYA Section</th>
<th>Wisconsin</th>
<th></th>
<th>Massachusetts</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg</td>
<td>High</td>
<td>Low</td>
<td>StDev</td>
</tr>
<tr>
<td>Middle</td>
<td>8.5</td>
<td>78.7</td>
<td>0.4</td>
<td>8.6</td>
</tr>
<tr>
<td>Bottom</td>
<td>8.8</td>
<td>97.3</td>
<td>0.6</td>
<td>9.1</td>
</tr>
</tbody>
</table>
4.3.2. *Signal Display Comparisons*

The main objective of this analysis was to identify if the signal display arrangement impacted driver comprehension for the experimental and baseline scenarios. Chi-squared analyses were completed to identify differences in the percentage of correct responses based on the signal display. The results are shown in Table 4-6.

**Table 4-6. Chi-Squared Analysis for Signal Display Comparisons**

<table>
<thead>
<tr>
<th>Display Type 1</th>
<th>Display Type 2</th>
<th>Wisconsin 1 (%)</th>
<th>Wisconsin 2 (%)</th>
<th>P Value</th>
<th>Massachusetts 1 (%)</th>
<th>Massachusetts 2 (%)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three-Section Vertical</td>
<td>Four-Section Vertical</td>
<td>78.6</td>
<td>76.9</td>
<td>0.4752</td>
<td>69.1</td>
<td>73.2</td>
<td>0.2238</td>
</tr>
<tr>
<td>Three-Section Vertical</td>
<td>Five-Section Clustered</td>
<td>78.6</td>
<td>78.8</td>
<td>0.8993</td>
<td>69.1</td>
<td>74.9</td>
<td><strong>0.0120</strong></td>
</tr>
<tr>
<td>Three-Section Vertical</td>
<td>Five Section Clustered w/ Simultaneous Display</td>
<td>78.6</td>
<td>75.8</td>
<td>0.0994</td>
<td>69.1</td>
<td>62.6</td>
<td><strong>0.0095</strong></td>
</tr>
<tr>
<td>Five-Section Clustered</td>
<td>Four-Section Vertical</td>
<td><strong>78.8</strong></td>
<td>76.9</td>
<td>0.4210</td>
<td><strong>74.9</strong></td>
<td>73.2</td>
<td>0.5973</td>
</tr>
<tr>
<td>Five-Section Clustered</td>
<td>Five Section Clustered w/ Simultaneous Display</td>
<td>78.8</td>
<td>75.8</td>
<td>0.0775</td>
<td><strong>74.9</strong></td>
<td>62.6</td>
<td><strong>0.0000</strong></td>
</tr>
<tr>
<td>Five Section Clustered w/ Simultaneous Display</td>
<td>Four-Section Vertical</td>
<td>75.8</td>
<td>76.9</td>
<td>0.6320</td>
<td>62.6</td>
<td>73.2</td>
<td><strong>0.0029</strong></td>
</tr>
</tbody>
</table>

*Percentage of Correct (Yield) responses for the corresponding Display Type*

In Wisconsin, the three-section vertical display had the highest correct response rate at 78.6 percent and the five-section clustered display with simultaneous indications had the lowest correct response rate at 75.8 percent. The five-section clustered display with simultaneous indications had lower correct response rate than both the three-section vertical and five-section clustered display, but the differences were not significant. There were no significant differences between the other displays, essentially meaning that there is no difference in comprehension between any of the signal displays.
In Massachusetts, the five-section clustered display had the highest correct response rate at 74.9 percent and the five-section clustered display with simultaneous indications had the lowest correct response rate at 62.6 percent. The five-section clustered display with simultaneous indications had a significantly lower correct response rate than all other signal displays. The five-section clustered display without simultaneous indications had a significantly higher correct response rate than the three-section vertical display. These results indicate that simultaneous indications reduce driver comprehension.

For the experimental displays in both states, the average response time was lowest for the three-section vertical display and highest for the five-section clustered display with simultaneous indications. The average response times are shown in Table 4-7. The fact that the average response time is highest for the five-section clustered display with simultaneous indications aligns with the fact that this signal display resulted in significantly lower percentages of correct responses compared to other signal displays.

<table>
<thead>
<tr>
<th>Display Type</th>
<th>Wisconsin</th>
<th>Massachusetts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg</td>
<td>High</td>
</tr>
<tr>
<td>Four-Section Vertical</td>
<td>8.6</td>
<td>80.1</td>
</tr>
<tr>
<td>Three-Section Vertical</td>
<td>8.2</td>
<td>75.6</td>
</tr>
<tr>
<td>Five-Section Clustered</td>
<td>8.4</td>
<td>74.2</td>
</tr>
<tr>
<td>Five Section Clustered w/ Simultaneous Indication</td>
<td>9.2</td>
<td>97.3</td>
</tr>
</tbody>
</table>

Table 4-7. Average Response Times based on Signal Display
Another objective of this section was to identify if the location of the FYA was comprehended differently for each of the experimental signal displays. Chi-squared analyses were completed to examine for differences between the FYA in the middle section and the FYA in the bottom section. The results are shown in Table 4-8.

There were no significant differences found in the chi-squared analysis. As result, no matter what display type was shown, there was not a significant difference in driver comprehension when the the FYA indication is located in the middle section compared to the bottom section. Additionally, plots were created that display the percentage of correct and fail-critical responses in Figure 4-1 and Figure 4-2 respectively. The confidence intervals on the plot overlap, confirming that there are no significant differences.

Table 4-8. Chi-Squared Analysis for FYA Location Comparisons based on Signal Display

<table>
<thead>
<tr>
<th>Display Type</th>
<th>FYA Location</th>
<th>Wisconsin (%)</th>
<th>P Value</th>
<th>Massachusetts (%)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three-Section Vertical</td>
<td>Middle</td>
<td>77.1</td>
<td>0.1531</td>
<td>68.0</td>
<td>0.4992</td>
</tr>
<tr>
<td></td>
<td>Bottom</td>
<td>80.5</td>
<td></td>
<td>70.4</td>
<td></td>
</tr>
<tr>
<td>Five-Section Clustered</td>
<td>Middle</td>
<td>79.1</td>
<td>0.8059</td>
<td>73.9</td>
<td>0.4726</td>
</tr>
<tr>
<td></td>
<td>Bottom</td>
<td>78.5</td>
<td></td>
<td>76.2</td>
<td></td>
</tr>
<tr>
<td>Five Section Clustered w/ Simultaneous Display</td>
<td>Middle</td>
<td>76.0</td>
<td>0.7968</td>
<td>62.0</td>
<td>0.7281</td>
</tr>
<tr>
<td></td>
<td>Bottom</td>
<td>75.4</td>
<td></td>
<td>63.3</td>
<td></td>
</tr>
</tbody>
</table>

*Percentage of Correct (Yield) responses.
Figure 4-1. Percentage of Correct Responses for FYA Location Comparisons based on Signal Display

Figure 4-2. Percentage of Fail-Critical Responses for FYA Location Comparisons based on Signal Display
4.3.3. Through Indication Comparisons

The main objective of this analysis was to identify if the through indication impacted driver comprehension for the experimental scenarios. Chi-squared analyses were completed to identify differences in the percentage of correct responses based on the through indication. The results are shown in Table 4-9.

Table 4-9. Chi-Squared Analysis for Through Indication Comparisons

<table>
<thead>
<tr>
<th>Through Indication 1</th>
<th>Through Indication 2</th>
<th>Wisconsin 1 (%)</th>
<th>Wisconsin 2 (%)</th>
<th>P Value</th>
<th>Massachusetts 1 (%)</th>
<th>Massachusetts 2 (%)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circular Green</td>
<td>Circular Yellow</td>
<td>89.7</td>
<td>74.6</td>
<td>0.0000</td>
<td>79.1</td>
<td>66.9</td>
<td>0.0000</td>
</tr>
<tr>
<td>Circular Green</td>
<td>Circular Red</td>
<td>89.7</td>
<td>66.9</td>
<td>0.0000</td>
<td>79.1</td>
<td>60.8</td>
<td>0.0000</td>
</tr>
<tr>
<td>Circular Yellow</td>
<td>Circular Red</td>
<td>74.6</td>
<td>66.9</td>
<td>0.0001</td>
<td>66.9</td>
<td>60.8</td>
<td>0.0160</td>
</tr>
</tbody>
</table>

*Percentage of Correct (Yield) responses for the corresponding Through Indication

In Wisconsin, the through indication had significant impacts on driver comprehension. The CG indication had the highest correct response rate at 89.7 percent, the CY indication had a correct response rate of 74.6 percent, and the CR indication had the lowest correct response rate at 66.9 percent. All of these differences were highly significant (p<0.01).

In Massachusetts, the through indication also had significant impacts on driver comprehension. The CG indication had the highest correct response rate at 79.1 percent, the CY indication had a correct response rate of 66.9 percent, and the CR indication had the lowest correct response rate at 60.8 percent. All of these differences were significant (p<0.05).
The average response time was close to equal for all scenarios in Wisconsin. Scenarios featuring a CG indication did have the lowest response time, but were only 0.2 seconds lower than the response times for scenarios featuring a CY or CR indication. In Massachusetts, the average response time showed a little more variation. The average response time was lowest for scenarios featuring a CG indication, while scenarios featuring a CR indication had the highest average response time. The average response times are shown in Table 4-10.

Table 4-10. Average Response Times based on Through Indication

<table>
<thead>
<tr>
<th>Through Indication</th>
<th>Wisconsin</th>
<th></th>
<th></th>
<th></th>
<th>Massachusetts</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg</td>
<td>High</td>
<td>Low</td>
<td>StDev</td>
<td>Avg</td>
<td>High</td>
<td>Low</td>
<td>StDev</td>
</tr>
<tr>
<td>Circular Green</td>
<td>8.5</td>
<td>78.7</td>
<td>0.8</td>
<td>9.2</td>
<td>7.4</td>
<td>66.8</td>
<td>1.1</td>
<td>7.3</td>
</tr>
<tr>
<td>Circular Yellow</td>
<td>8.7</td>
<td>75.6</td>
<td>0.4</td>
<td>8.6</td>
<td>8.6</td>
<td>75.8</td>
<td>1.2</td>
<td>9.5</td>
</tr>
<tr>
<td>Circular Red</td>
<td>8.7</td>
<td>97.3</td>
<td>0.8</td>
<td>8.6</td>
<td>8.5</td>
<td>104.4</td>
<td>0.6</td>
<td>9.8</td>
</tr>
</tbody>
</table>
Another objective of this section was to identify if the location of the FYA was comprehended differently for each of the through indication. Chi-squared analyses were completed to examine for differences between the FYA in the middle section and the FYA in the bottom section. The results are shown in Table 4-11. Additionally, plots were created that display the percentage of correct and fail-critical responses in Figure 4-3 and Figure 4-4 respectively. In the chi-squared analysis, there were no significant differences in Wisconsin or Massachusetts. Additionally, the confidence intervals in both plots overlap, confirming that there are no significant differences.

Table 4-11. Chi-Squared Analysis FYA Location
Comparisons based on Through Indication

<table>
<thead>
<tr>
<th>Through Indication</th>
<th>FYA Location</th>
<th>Wisconsin (%)*</th>
<th>P Value</th>
<th>Massachusetts (%)*</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circular Green</td>
<td>Middle</td>
<td>89.6</td>
<td>0.8376</td>
<td>78.4</td>
<td>0.6069</td>
</tr>
<tr>
<td></td>
<td>Bottom</td>
<td>89.9</td>
<td></td>
<td>80.0</td>
<td></td>
</tr>
<tr>
<td>Circular Yellow</td>
<td>Middle</td>
<td>74.9</td>
<td>0.8077</td>
<td>67.0</td>
<td>0.9495</td>
</tr>
<tr>
<td></td>
<td>Bottom</td>
<td>74.3</td>
<td></td>
<td>66.8</td>
<td></td>
</tr>
<tr>
<td>Circular Red</td>
<td>Middle</td>
<td>65.6</td>
<td>0.2785</td>
<td>58.5</td>
<td>0.1720</td>
</tr>
<tr>
<td></td>
<td>Bottom</td>
<td>68.7</td>
<td></td>
<td>63.6</td>
<td></td>
</tr>
</tbody>
</table>

*Percentage of Correct (Yield) responses
Figure 4-3. Percentage of Correct Responses for FYA Location Comparisons based on Through Indication

Figure 4-4. Percentage of Fail-Critical Responses for FYA Location Comparisons based on Through Indication
4.3.4. *Signal Display and Through Indication Comparisons*

Since the through indication appears to significantly impact driver comprehension, another analysis was completed to examine the impacts when both the signal display and through indication are considered. The main objective of this analysis was to identify if the location of the FYA was comprehended differently for each combination of signal display and through indication. Due to the limited sample size in Massachusetts, only the Wisconsin data was used for this analysis. A plot was created for this analysis, and is shown in Figure 4-5 on the next page.

The results show that the CG through indication has an extremely high correct response rate for all of the experimental signal displays. By examining the confidence intervals, it is obvious that there is no significant difference in driver comprehension when the FYA is in the middle section compared to the bottom section.

When the through indication was CY, the correct response rate was significantly lower than when the through indication was CG. Once again though, the overlapping confidence intervals indicate that there is no significant difference in driver comprehension when the FYA is in the middle section compared to the bottom section.

The CR through indication also had a significantly lower correct response rate than the CG through indication. There was a little more variation based on the location of the FYA in the scenarios involving a CR, but the confidence intervals still overlap in each of the three display types. Again, this indicates that there was no significant difference in driver comprehension when the FYA was in the middle section compared to the bottom section.
Figure 4-5. Percentage of Correct Responses in Wisconsin for FYA Location Comparisons based on Signal Display and Through Indication
4.3.5. **Opposing Traffic Comparisons**

The objective of this analysis was to identify if the presence of opposing traffic impacted driver comprehension for the experimental scenarios. Chi-squared analyses were completed to identify differences in the percentage of correct responses based on the presence of opposing traffic. The results are shown in Table 4-12. There were no significant differences found in the chi-squared analysis. This essentially means that the presence of opposing traffic had no impact on driver comprehension.

**Table 4-12. Chi-Squared Analysis for Opposing Traffic Comparisons**

<table>
<thead>
<tr>
<th>Opposing Traffic</th>
<th>Wisconsin (%)*</th>
<th>P Value</th>
<th>Massachusetts (%)*</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>77.1</td>
<td>0.3374</td>
<td>68.7</td>
<td>0.7640</td>
</tr>
<tr>
<td>No</td>
<td>78.4</td>
<td></td>
<td>69.3</td>
<td></td>
</tr>
</tbody>
</table>

*Percentage of Correct (Yield) responses

The average response time was slightly lower when there was no opposing traffic in both states. This should be expected, as the presence of the opposing traffic introduces another object for participants to comprehend prior to making a decision. The average response times are shown in Table 4-13.

**Table 4-13. Average Response Times based on Opposing Traffic**

<table>
<thead>
<tr>
<th>Opposing Traffic</th>
<th>Wisconsin</th>
<th></th>
<th>Massachusetts</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg</td>
<td>High</td>
<td>Low</td>
<td>StDev</td>
</tr>
<tr>
<td>Yes</td>
<td>8.7</td>
<td>97.3</td>
<td>0.4</td>
<td>8.7</td>
</tr>
<tr>
<td>No</td>
<td>8.5</td>
<td>78.7</td>
<td>0.6</td>
<td>8.9</td>
</tr>
</tbody>
</table>
4.3.6. **Demographic Comparisons**

The objective of this analysis was to identify if driving experience or age impacted driver comprehension experimental scenarios. Chi-squared analyses were completed to identify differences in the percentage of correct responses based on driving experience and age. The results from the driving experience analysis are shown in Table 4-14. The results from the age analysis are shown in Table 4-15.

**Table 4-14. Chi-Squared Analysis for Driving Experience Comparisons**

<table>
<thead>
<tr>
<th>Driving Experience 1</th>
<th>Driving Experience 2</th>
<th>Wisconsin 1 (%)*</th>
<th>Wisconsin 2 (%)*</th>
<th>P Value</th>
<th>Massachusetts 1 (%)*</th>
<th>Massachusetts 2 (%)*</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5 Years</td>
<td>5 to 10 Years</td>
<td>68.3</td>
<td>81.1</td>
<td>0.0000</td>
<td>67.7</td>
<td>71.4</td>
<td>0.1605</td>
</tr>
<tr>
<td>Less than 5 Years</td>
<td>More than 10 Years</td>
<td>68.3</td>
<td>82.5</td>
<td>0.0000</td>
<td>67.7</td>
<td>70.1</td>
<td>0.3148</td>
</tr>
<tr>
<td>5 to 10 Years</td>
<td>More than 10 Years</td>
<td>81.1</td>
<td>82.5</td>
<td>0.4201</td>
<td>71.4</td>
<td>70.1</td>
<td>0.6660</td>
</tr>
</tbody>
</table>

*Percentage of Correct (Yield) responses for the corresponding Driving Experience

**Table 4-15. Chi-Squared Analysis for Age Comparisons**

<table>
<thead>
<tr>
<th>Age Group 1</th>
<th>Age Group 2</th>
<th>Wisconsin 1 (%)*</th>
<th>Wisconsin 2 (%)*</th>
<th>P Value</th>
<th>Massachusetts 1 (%)*</th>
<th>Massachusetts 2 (%)*</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-24</td>
<td>25-44</td>
<td>71.9</td>
<td>85.0</td>
<td>0.0000</td>
<td>68.3</td>
<td>59.9</td>
<td>0.0225</td>
</tr>
<tr>
<td>18-24</td>
<td>45-64</td>
<td>71.9</td>
<td>81.3</td>
<td>0.0000</td>
<td>68.3</td>
<td>77.2</td>
<td>0.0011</td>
</tr>
<tr>
<td>18-24</td>
<td>65+</td>
<td>71.9</td>
<td>78.8</td>
<td>0.0069</td>
<td>68.3</td>
<td>69.4</td>
<td>0.8325</td>
</tr>
<tr>
<td>25-44</td>
<td>45-64</td>
<td>85.0</td>
<td>81.3</td>
<td>0.0469</td>
<td>59.9</td>
<td>77.2</td>
<td>0.0000</td>
</tr>
<tr>
<td>25-44</td>
<td>65+</td>
<td>85.0</td>
<td>78.8</td>
<td>0.0091</td>
<td>59.9</td>
<td>69.4</td>
<td>0.1561</td>
</tr>
<tr>
<td>45-64</td>
<td>65+</td>
<td>81.3</td>
<td>78.8</td>
<td>0.3229</td>
<td>77.2</td>
<td>69.4</td>
<td>0.1616</td>
</tr>
</tbody>
</table>

*Percentage of Correct (Yield) responses for the corresponding Age Group
In Wisconsin, participants with less than 5 years of driving experience had a significantly lower correct response rate than participants with more than 5 years of experience. Age also played a significant role in correct response rate. The 25-44 year old age group had the highest correct response rate at 85.0 percent, while the 18-24 year old age group had the lowest correct response rate at 71.9 percent. The 25-44 group had a significantly higher correct response rate compared to all other age groups. The 18-24 group had a significantly lower correct response rate compared to all other age groups.

In Massachusetts, participants with less than 5 years of driving experience also had a lower correct response rate than participants with more than 5 years of experience, but none of the differences were significant. For the age analysis, almost 90 percent of the participants were between the ages of 18 and 24. As a result, the sample size for other age groups are extremely small and are likely not truly representative of the population. Due to this fact, the results from the Massachusetts age analysis were not used to make any observations. The results are still shown in the tables and plots associated with the age analysis.
The average response times based on driving experience and age are shown in Table 4-16 and Table 4-17 respectively. In both states, the average response time increased as age increased. This is not surprising, as people get older their response times tend to become slower. Since age is strongly correlated with driving experience, participants with more than 10 years of driving experience also had much longer response times than other participants.

### Table 4-16. Average Response Times based on Driving Experience

<table>
<thead>
<tr>
<th>Driving Experience</th>
<th>Wisconsin</th>
<th>Massachusetts</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Less than 5 Years</td>
<td>6.5</td>
<td>59.8</td>
<td>0.4</td>
</tr>
<tr>
<td>5 to 10 Years</td>
<td>5.6</td>
<td>54.9</td>
<td>0.8</td>
</tr>
<tr>
<td>More than 10 Years</td>
<td>11.2</td>
<td>97.3</td>
<td>1.1</td>
</tr>
</tbody>
</table>

### Table 4-17. Average Response Times based on Age

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Wisconsin</th>
<th>Massachusetts</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Avg</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>18 to 24</td>
<td>5.9</td>
<td>58.5</td>
<td>0.4</td>
</tr>
<tr>
<td>25 to 44</td>
<td>7.1</td>
<td>70.2</td>
<td>1.1</td>
</tr>
<tr>
<td>45 to 64</td>
<td>11.4</td>
<td>97.3</td>
<td>1.8</td>
</tr>
<tr>
<td>65+</td>
<td>17.0</td>
<td>75.6</td>
<td>2.6</td>
</tr>
</tbody>
</table>
4.4. Observations from Evaluation

In addition to the statistical analysis, several observations were made by the researchers in Madison, Wisconsin that assisted with conducting the evaluation. Although, none of these observations have statistical and scientific merit, they are useful. Below is a brief summary of the observations made:

- Most participants commented that they were being asked the same question over and over again. This indicates that many participants did not even realize that the FYA indication was being displayed in different sections throughout the evaluation. This aligns well with the results from the statistical analysis, as driver comprehension was not different when the FYA occurred in the middle section compared to the bottom section.

- When presented with a solid YA, some participants stated that the correct answer was not available, and that they thought the correct answer was ‘prepare to stop’.

- In Wisconsin, most applications of the FYA feature a supplemental sign explaining the drivers should yield when the arrow is flashing. Some participants commented that they find the use of a supplemental sign helpful.
5. CONCLUSIONS AND FUTURE WORK

5.1. Conclusions

The objective of this research was to analyze the driver comprehension impacts of retrofitting existing signal displays with the FYA. This was accomplished by conducting a static, computer-based evaluation at various locations across Madison, Wisconsin and Amherst, Massachusetts. The results from the evaluation were analyzed to determine if the location of the FYA within any given signal arrangement and display configuration has a significant impact on driver comprehension. In addition, other variables were analyzed to determine if they had any impact on driver comprehension. These variables included the signal display arrangement, the through indication, the presence of opposing traffic, and demographics.

For all signal display arrangements, there was not a significant difference in driver comprehension when the FYA indication was located in the middle section compared to the bottom section. In Wisconsin, scenarios involving a FYA indication in the middle section had a correct response rate of 77.4 percent, while scenarios involving a FYA indication in the bottom section had a correct response rate of 78.1 percent. In Massachusetts, the correct response rates were 68.1 percent and 70.0 percent respectively. Analyses were also completed to determine if the location of the FYA was comprehended differently for a given signal display or through indication. In every analysis, there were no significant differences.

When considering the signal arrangement, driver comprehension was the lowest for the five-section clustered display with simultaneous indications. In Wisconsin, the differences between this display and other display types was not significant, but in
Massachusetts, the five-section clustered display had a significantly higher correct response rate compared to the same display with simultaneous indications. The fact that the five-section clustered display with simultaneous indication had the lowest correct response rate in both of the states is not surprising, as previous research completed by Knodler, et al. had shown that drivers have a difficult time understanding simultaneous indications [7]. The results show that the display type does not impact driver comprehension of the FYA, as long as simultaneous indications are not used.

Driver comprehension was significantly impacted by the through indication in Wisconsin. The CG had the highest correct response rate at 89.7 percent, followed by the CY with a correct response rate of 74.6 percent. The CR had the lowest correct response rate at 66.9 percent. The differences between each of these through indications was statistically significant. Massachusetts had similar results with correct response rates of 79.1 percent, 69.9 percent, and 60.8 percent respectively. In Massachusetts, the CG was comprehended significantly better than both the CY and CR. The results show that the through indication has a large impact on driver comprehension. The correct response rate approached 90 percent in Wisconsin, when the through indication was CG.

When considering the presence of opposing traffic, there were no significant differences found in the analysis. This essentially means that the presence of opposing traffic had no impact on driver comprehension.
Driving experience and age also significantly impacted driver comprehension. In Wisconsin, participants with less than 5 years of driving experience had a significantly lower correct response rate than drivers with more than 5 years of experience. The 25-44 group had a significantly higher correct response rate compared to all other age groups. The 18-24 group had a significantly lower correct response rate compared to all other age groups.

Altogether, the answer to the primary objective of this research is that there is not a significant difference in driver comprehension when the FYA occurs in the bottom section compared to the middle section. The signal display arrangement does not impact driver comprehension of the FYA, as long as simultaneous indications are not used. In the case of the five-section clustered signal display, it is likely that simultaneous indications would be used in a retrofit application in order to satisfy the MUTCD requirement of having two through indications displayed at an intersection. The through indication has a significant impact on driver comprehension, with the CG having the highest levels of driver comprehension and the CR having the lowest levels of driver comprehension. The presence of opposing traffic did not have an impact on driver comprehension. Driving experience improves driver comprehension to an extent, but as people age, driver comprehension tends to decrease. In conclusion, retrofitting existing three-section vertical signal displays with a bimodal FYA has strong potential of being a viable option moving forward. However, more research should be completed prior to recommending any policy changes.
5.2. Future Work

Future research includes completing a dynamic driving simulator study that also examines if the location of the FYA within any given signal arrangement has a significant impact on driver comprehension. It is recommended that the use of simultaneous indications not be included in this study, as scenarios involving simultaneous indications had a lower correct response rate than other scenarios. In addition to studying if the location of the FYA impacts driver comprehension, special attention should be given to the through indication since the results showed that the through indication significantly impacted driver comprehension.

Other potential research includes studying the impact of the bimodal display on the other indication used in the bimodal section. Displaying a FYA in the GA section could have negative impacts for people who have visual color deficiencies. Displaying a FYA in the YA section could have negative impacts when the signal transitions from FYA to YA to RA. This is because the transition from the flashing to solid YA would be occurring in the same signal section and might be difficult for drivers to recognize.

Also, there is currently a fair amount of controversy among traffic engineers regarding the use of a supplemental sign and transition to and from the FYA phase interval. Both of these topics should be researched and standards should be set to ensure that the use of the FYA is consistent across the country.
5.3. **Contributions**

Ultimately, this research showed that retrofitting existing signal displays with a bimodal FYA has strong potential of being a viable option moving forward. This research lays the framework for the initial stages of implementing a policy change in the MUTCD that allows existing signal displays to be retrofitted with a bimodal FYA. As mentioned in the previous section, future research must be completed prior to actually making a policy change.

Additionally, this research shows that driver comprehension is significantly impacted by the through indication. These results are also backed up by previous research. This should be a concern of traffic engineers, as it shows that drivers are likely using the through indication to decide how to respond to a FYA. This research highlights this issue, and identifies it as a key issue to address in future research.
6. APPENDIX

6.1. Evaluation Screenshots

Thank you for agreeing to participate in this important study. Our objective is to evaluate the effectiveness of different types of traffic signal lights. The responses that you provide are anonymous. You will also be asked to provide demographic information. However, you will not be asked to provide your name or any other identifiable information of personal nature. Responses and related survey data will be reviewed and analyzed only by members of the NCHRP 20-7 Task 283 research team.

If you choose to participate in the study you need to click on the “I Agree” button below. Once you click on the button you will be taken to a demographics data collection screen followed by a practice scenario where you will learn how to operate the study software. After the practice scenario the study will begin.

![I Agree, Let's Proceed]

Let's start with some basic demographics

Your Gender:  Female  Male

Your Age:  18-24  25-34  35-44  45-54  55-64  65-74  75+

Years of driving experience:  Less than 5 years  5 to 9 years  10 years or more

Start Practice

The first scenario you will see is going to be a practice one with instructions.
If you want to turn left and see the signal indications shown below, you are...

- not allowed to turn left, stop
- allowed to turn left; however, you must wait for a large enough opening in the oncoming traffic before doing so, yield
- allowed to turn left since the oncoming traffic must stop, go
- not sure whether or not a left-turn is allowed

Submit Sample Questions

Traffic Operations and Safety (TOS) Laboratory
Thanks for participating in the survey!
### 6.2. Summary of Responses for All Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Type</th>
<th>Left-Turn Display</th>
<th>Thru Display</th>
<th>Opposing Traffic</th>
<th>Solution</th>
<th>Total Responses</th>
<th>Stop (%)</th>
<th>Yield (%)</th>
<th>Go (%)</th>
<th>IDK (%)</th>
<th>Correct (%)</th>
<th>Avg Time (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>02</td>
<td>Control</td>
<td><img src="image" alt="Left-Turn Display" /></td>
<td><img src="image" alt="Thru Display" /></td>
<td>Yes</td>
<td>Go</td>
<td>51</td>
<td>0.0</td>
<td>7.8</td>
<td>92.2</td>
<td>0.0</td>
<td>92.2</td>
<td>6.41</td>
</tr>
<tr>
<td>16</td>
<td>Control</td>
<td><img src="image" alt="Left-Turn Display" /></td>
<td><img src="image" alt="Thru Display" /></td>
<td>No</td>
<td>Go</td>
<td>64</td>
<td>0.0</td>
<td>14.1</td>
<td>85.9</td>
<td>0.0</td>
<td>85.9</td>
<td>6.52</td>
</tr>
<tr>
<td>01</td>
<td>Control</td>
<td><img src="image" alt="Left-Turn Display" /></td>
<td><img src="image" alt="Thru Display" /></td>
<td>Yes</td>
<td>Go</td>
<td>55</td>
<td>3.6</td>
<td>3.6</td>
<td>90.9</td>
<td>1.8</td>
<td>90.9</td>
<td>6.08</td>
</tr>
<tr>
<td>03</td>
<td>Control</td>
<td><img src="image" alt="Left-Turn Display" /></td>
<td><img src="image" alt="Thru Display" /></td>
<td>Yes</td>
<td>Any</td>
<td>62</td>
<td>24.2</td>
<td>61.3</td>
<td>14.5</td>
<td>0.0</td>
<td>100.0</td>
<td>11.12</td>
</tr>
<tr>
<td>04</td>
<td>Control</td>
<td><img src="image" alt="Left-Turn Display" /></td>
<td><img src="image" alt="Thru Display" /></td>
<td>No</td>
<td>Any</td>
<td>48</td>
<td>14.6</td>
<td>64.6</td>
<td>18.8</td>
<td>2.1</td>
<td>100.0</td>
<td>9.72</td>
</tr>
<tr>
<td>05</td>
<td>Control</td>
<td><img src="image" alt="Left-Turn Display" /></td>
<td><img src="image" alt="Thru Display" /></td>
<td>Yes</td>
<td>Any</td>
<td>52</td>
<td>36.5</td>
<td>40.4</td>
<td>15.4</td>
<td>7.7</td>
<td>100.0</td>
<td>8.59</td>
</tr>
<tr>
<td>06</td>
<td>Control</td>
<td><img src="image" alt="Left-Turn Display" /></td>
<td><img src="image" alt="Thru Display" /></td>
<td>No</td>
<td>Any</td>
<td>63</td>
<td>34.9</td>
<td>44.4</td>
<td>15.9</td>
<td>4.8</td>
<td>100.0</td>
<td>10.43</td>
</tr>
<tr>
<td>07</td>
<td>Control</td>
<td><img src="image" alt="Left-Turn Display" /></td>
<td><img src="image" alt="Thru Display" /></td>
<td>Yes</td>
<td>Any</td>
<td>44</td>
<td>52.3</td>
<td>25.0</td>
<td>18.2</td>
<td>4.5</td>
<td>100.0</td>
<td>9.20</td>
</tr>
<tr>
<td>08</td>
<td>Control</td>
<td><img src="image" alt="Left-Turn Display" /></td>
<td><img src="image" alt="Thru Display" /></td>
<td>No</td>
<td>Any</td>
<td>47</td>
<td>27.7</td>
<td>42.6</td>
<td>25.5</td>
<td>4.3</td>
<td>100.0</td>
<td>11.51</td>
</tr>
<tr>
<td>15</td>
<td>Control</td>
<td><img src="image" alt="Left-Turn Display" /></td>
<td><img src="image" alt="Thru Display" /></td>
<td>Yes</td>
<td>Stop</td>
<td>58</td>
<td>94.8</td>
<td>3.4</td>
<td>0.0</td>
<td>1.7</td>
<td>94.8</td>
<td>6.71</td>
</tr>
<tr>
<td>Scenario</td>
<td>Type</td>
<td>Left-Turn Display</td>
<td>Thru Display</td>
<td>Opposing Traffic</td>
<td>Solution</td>
<td>Total Responses</td>
<td>Stop (%)</td>
<td>Yield (%)</td>
<td>Go (%)</td>
<td>IDK (%)</td>
<td>Correct (%)</td>
<td>Avg Time (sec)</td>
</tr>
<tr>
<td>----------</td>
<td>------</td>
<td>------------------</td>
<td>--------------</td>
<td>------------------</td>
<td>----------</td>
<td>----------------</td>
<td>----------</td>
<td>-----------</td>
<td>--------</td>
<td>---------</td>
<td>-------------</td>
<td>----------------</td>
</tr>
<tr>
<td>24</td>
<td>Control</td>
<td>![Signal]</td>
<td>![Signal]</td>
<td>No</td>
<td>Go</td>
<td>51</td>
<td>0.0</td>
<td>15.7</td>
<td>84.3</td>
<td>0.0</td>
<td>84.3</td>
<td>7.59</td>
</tr>
<tr>
<td>23</td>
<td>Control</td>
<td>![Signal]</td>
<td>![Signal]</td>
<td>Yes</td>
<td>Stop</td>
<td>52</td>
<td>92.3</td>
<td>3.8</td>
<td>0.0</td>
<td>3.8</td>
<td>92.3</td>
<td>5.64</td>
</tr>
<tr>
<td>32</td>
<td>Control</td>
<td>![Signal]</td>
<td>![Signal]</td>
<td>No</td>
<td>Go</td>
<td>45</td>
<td>0.0</td>
<td>0.0</td>
<td>100.0</td>
<td>0.0</td>
<td>100.0</td>
<td>6.45</td>
</tr>
<tr>
<td>31</td>
<td>Control</td>
<td>![Signal]</td>
<td>![Signal]</td>
<td>Yes</td>
<td>Stop</td>
<td>64</td>
<td>96.9</td>
<td>3.1</td>
<td>0.0</td>
<td>0.0</td>
<td>96.9</td>
<td>5.54</td>
</tr>
<tr>
<td>Scenario</td>
<td>Type</td>
<td>Left-Turn Display</td>
<td>Thru Display</td>
<td>Opposing Traffic</td>
<td>Solution</td>
<td>Total Responses</td>
<td>Stop (%)</td>
<td>Yield (%)</td>
<td>Go (%)</td>
<td>IDK (%)</td>
<td>Correct (%)</td>
<td>Avg Time (sec)</td>
</tr>
<tr>
<td>----------</td>
<td>--------</td>
<td>-------------------</td>
<td>--------------</td>
<td>------------------</td>
<td>----------</td>
<td>-----------------</td>
<td>----------</td>
<td>-----------</td>
<td>--------</td>
<td>---------</td>
<td>-------------</td>
<td>----------------</td>
</tr>
<tr>
<td>34</td>
<td>Control</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image2" alt="Image" /></td>
<td>Yes</td>
<td>Go</td>
<td>52</td>
<td>0.0</td>
<td>13.5</td>
<td>86.5</td>
<td>0.0</td>
<td>86.5</td>
<td>9.02</td>
</tr>
<tr>
<td>48</td>
<td>Control</td>
<td><img src="image3" alt="Image" /></td>
<td><img src="image4" alt="Image" /></td>
<td>No</td>
<td>Go</td>
<td>55</td>
<td>0.0</td>
<td>10.9</td>
<td>89.1</td>
<td>0.0</td>
<td>89.1</td>
<td>8.84</td>
</tr>
<tr>
<td>33</td>
<td>Control</td>
<td><img src="image5" alt="Image" /></td>
<td><img src="image6" alt="Image" /></td>
<td>Yes</td>
<td>Go</td>
<td>56</td>
<td>0.0</td>
<td>12.5</td>
<td>85.7</td>
<td>1.8</td>
<td>85.7</td>
<td>9.28</td>
</tr>
<tr>
<td>35</td>
<td>Control</td>
<td><img src="image7" alt="Image" /></td>
<td><img src="image8" alt="Image" /></td>
<td>Yes</td>
<td>Any</td>
<td>61</td>
<td>24.6</td>
<td>59.0</td>
<td>13.1</td>
<td>3.3</td>
<td>100.0</td>
<td>9.82</td>
</tr>
<tr>
<td>36</td>
<td>Control</td>
<td><img src="image9" alt="Image" /></td>
<td><img src="image10" alt="Image" /></td>
<td>No</td>
<td>Any</td>
<td>64</td>
<td>28.1</td>
<td>54.7</td>
<td>15.6</td>
<td>1.6</td>
<td>100.0</td>
<td>9.54</td>
</tr>
<tr>
<td>37</td>
<td>Control</td>
<td><img src="image11" alt="Image" /></td>
<td><img src="image12" alt="Image" /></td>
<td>Yes</td>
<td>Any</td>
<td>49</td>
<td>38.8</td>
<td>44.9</td>
<td>10.2</td>
<td>6.1</td>
<td>100.0</td>
<td>10.18</td>
</tr>
<tr>
<td>38</td>
<td>Control</td>
<td><img src="image13" alt="Image" /></td>
<td><img src="image14" alt="Image" /></td>
<td>No</td>
<td>Any</td>
<td>49</td>
<td>30.8</td>
<td>42.9</td>
<td>22.4</td>
<td>4.1</td>
<td>100.0</td>
<td>10.91</td>
</tr>
<tr>
<td>39</td>
<td>Control</td>
<td><img src="image15" alt="Image" /></td>
<td><img src="image16" alt="Image" /></td>
<td>Yes</td>
<td>Any</td>
<td>53</td>
<td>26.4</td>
<td>47.2</td>
<td>18.9</td>
<td>7.5</td>
<td>100.0</td>
<td>10.46</td>
</tr>
<tr>
<td>40</td>
<td>Control</td>
<td><img src="image17" alt="Image" /></td>
<td><img src="image18" alt="Image" /></td>
<td>No</td>
<td>Any</td>
<td>40</td>
<td>32.5</td>
<td>45.0</td>
<td>15.0</td>
<td>7.5</td>
<td>100.0</td>
<td>9.88</td>
</tr>
<tr>
<td>47</td>
<td>Control</td>
<td><img src="image19" alt="Image" /></td>
<td><img src="image20" alt="Image" /></td>
<td>Yes</td>
<td>Stop</td>
<td>51</td>
<td>98.0</td>
<td>2.0</td>
<td>0.0</td>
<td>0.0</td>
<td>98.0</td>
<td>5.85</td>
</tr>
<tr>
<td>Scenario</td>
<td>Type</td>
<td>Left-Turn Display</td>
<td>Thru Display</td>
<td>Opposing Traffic</td>
<td>Solution</td>
<td>Total Responses</td>
<td>Stop (%)</td>
<td>Yield (%)</td>
<td>Go (%)</td>
<td>IDK (%)</td>
<td>Correct (%)</td>
<td>Avg Time (sec)</td>
</tr>
<tr>
<td>----------</td>
<td>---------</td>
<td>-------------------</td>
<td>--------------</td>
<td>------------------</td>
<td>----------</td>
<td>-----------------</td>
<td>----------</td>
<td>-----------</td>
<td>--------</td>
<td>---------</td>
<td>-------------</td>
<td>----------------</td>
</tr>
<tr>
<td>50</td>
<td>Control</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image1" alt="Image" /></td>
<td>Yes</td>
<td>Go</td>
<td>99</td>
<td>0.0</td>
<td>14.1</td>
<td>85.9</td>
<td>0.0</td>
<td>85.9</td>
<td>6.68</td>
</tr>
<tr>
<td>64</td>
<td>Control</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image1" alt="Image" /></td>
<td>No</td>
<td>Go</td>
<td>56</td>
<td>0.0</td>
<td>5.4</td>
<td>94.6</td>
<td>0.0</td>
<td>94.6</td>
<td>8.03</td>
</tr>
<tr>
<td>49</td>
<td>Control</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image1" alt="Image" /></td>
<td>Yes</td>
<td>Go</td>
<td>53</td>
<td>1.9</td>
<td>13.2</td>
<td>81.1</td>
<td>3.8</td>
<td>81.1</td>
<td>10.16</td>
</tr>
<tr>
<td>51</td>
<td>Control</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image1" alt="Image" /></td>
<td>Yes</td>
<td>Any</td>
<td>44</td>
<td>20.5</td>
<td>59.1</td>
<td>18.2</td>
<td>2.3</td>
<td>100.0</td>
<td>9.67</td>
</tr>
<tr>
<td>52</td>
<td>Control</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image1" alt="Image" /></td>
<td>No</td>
<td>Any</td>
<td>53</td>
<td>17.0</td>
<td>67.9</td>
<td>15.1</td>
<td>0.0</td>
<td>100.0</td>
<td>9.59</td>
</tr>
<tr>
<td>53</td>
<td>Control</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image1" alt="Image" /></td>
<td>Yes</td>
<td>Any</td>
<td>52</td>
<td>38.5</td>
<td>42.3</td>
<td>17.3</td>
<td>1.9</td>
<td>100.0</td>
<td>9.67</td>
</tr>
<tr>
<td>54</td>
<td>Control</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image1" alt="Image" /></td>
<td>No</td>
<td>Any</td>
<td>47</td>
<td>38.3</td>
<td>38.3</td>
<td>17.0</td>
<td>6.4</td>
<td>100.0</td>
<td>9.43</td>
</tr>
<tr>
<td>55</td>
<td>Control</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image1" alt="Image" /></td>
<td>Yes</td>
<td>Any</td>
<td>60</td>
<td>43.3</td>
<td>23.3</td>
<td>15.0</td>
<td>18.3</td>
<td>100.0</td>
<td>9.89</td>
</tr>
<tr>
<td>56</td>
<td>Control</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image1" alt="Image" /></td>
<td>No</td>
<td>Any</td>
<td>51</td>
<td>43.1</td>
<td>31.4</td>
<td>11.8</td>
<td>13.7</td>
<td>100.0</td>
<td>12.09</td>
</tr>
<tr>
<td>67</td>
<td>Control</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image1" alt="Image" /></td>
<td>Yes</td>
<td>Yield</td>
<td>42</td>
<td>9.5</td>
<td>73.8</td>
<td>11.9</td>
<td>4.8</td>
<td>73.8</td>
<td>9.18</td>
</tr>
<tr>
<td>66</td>
<td>Control</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image1" alt="Image" /></td>
<td>No</td>
<td>Yield</td>
<td>57</td>
<td>5.3</td>
<td>82.5</td>
<td>3.5</td>
<td>8.8</td>
<td>82.5</td>
<td>9.28</td>
</tr>
<tr>
<td>63</td>
<td>Control</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image1" alt="Image" /></td>
<td>Yes</td>
<td>Stop</td>
<td>49</td>
<td>95.9</td>
<td>2.0</td>
<td>0.0</td>
<td>2.0</td>
<td>95.9</td>
<td>5.79</td>
</tr>
<tr>
<td>Scenario</td>
<td>Type</td>
<td>Left-Turn Display</td>
<td>Thru Display</td>
<td>Opposing Traffic</td>
<td>Solution</td>
<td>Total Responses</td>
<td>Stop (%)</td>
<td>Yield (%)</td>
<td>Go (%)</td>
<td>IDK (%)</td>
<td>Correct (%)</td>
<td>Avg Time (sec)</td>
</tr>
<tr>
<td>----------</td>
<td>--------</td>
<td>-------------------</td>
<td>--------------</td>
<td>------------------</td>
<td>----------</td>
<td>-----------------</td>
<td>----------</td>
<td>-----------</td>
<td>--------</td>
<td>---------</td>
<td>-------------</td>
<td>----------------</td>
</tr>
<tr>
<td>17</td>
<td>Baseline</td>
<td>![Image]</td>
<td>![Image]</td>
<td>Yes</td>
<td>Yield</td>
<td>136</td>
<td>5.9</td>
<td>80.9</td>
<td>8.8</td>
<td>4.4</td>
<td>80.9</td>
<td>8.25</td>
</tr>
<tr>
<td>18</td>
<td>Baseline</td>
<td>![Image]</td>
<td>![Image]</td>
<td>No</td>
<td>Yield</td>
<td>143</td>
<td>1.4</td>
<td>87.4</td>
<td>11.2</td>
<td>0.0</td>
<td>87.4</td>
<td>8.74</td>
</tr>
<tr>
<td>19</td>
<td>Baseline</td>
<td>![Image]</td>
<td>![Image]</td>
<td>Yes</td>
<td>Yield</td>
<td>52</td>
<td>15.4</td>
<td>71.2</td>
<td>3.8</td>
<td>9.6</td>
<td>71.2</td>
<td>7.80</td>
</tr>
<tr>
<td>20</td>
<td>Baseline</td>
<td>![Image]</td>
<td>![Image]</td>
<td>No</td>
<td>Yield</td>
<td>49</td>
<td>10.2</td>
<td>75.5</td>
<td>8.2</td>
<td>6.1</td>
<td>75.5</td>
<td>9.91</td>
</tr>
<tr>
<td>21</td>
<td>Baseline</td>
<td>![Image]</td>
<td>![Image]</td>
<td>Yes</td>
<td>Yield</td>
<td>146</td>
<td>15.8</td>
<td>65.1</td>
<td>7.5</td>
<td>11.6</td>
<td>65.1</td>
<td>7.68</td>
</tr>
<tr>
<td>22</td>
<td>Baseline</td>
<td>![Image]</td>
<td>![Image]</td>
<td>No</td>
<td>Yield</td>
<td>129</td>
<td>10.1</td>
<td>70.5</td>
<td>11.6</td>
<td>7.8</td>
<td>70.5</td>
<td>9.66</td>
</tr>
<tr>
<td>Scenario</td>
<td>Type</td>
<td>Left-Turn Display</td>
<td>Thru Display</td>
<td>Opposing Traffic</td>
<td>Solution</td>
<td>Total Responses</td>
<td>Stop (%)</td>
<td>Yield (%)</td>
<td>Go (%)</td>
<td>IDK (%)</td>
<td>Correct (%)</td>
<td>Avg Time (sec)</td>
</tr>
<tr>
<td>----------</td>
<td>--------</td>
<td>-------------------</td>
<td>--------------</td>
<td>------------------</td>
<td>----------</td>
<td>-----------------</td>
<td>----------</td>
<td>-----------</td>
<td>--------</td>
<td>----------</td>
<td>-------------</td>
<td>----------------</td>
</tr>
<tr>
<td>27</td>
<td>Baseline</td>
<td><img src="image1" alt="Left-Turn Display" /> <img src="image2" alt="Thru Display" /> <img src="image3" alt="Opposing Traffic" /> Yes Yield</td>
<td>55</td>
<td>18.2</td>
<td>65.5</td>
<td>7.3</td>
<td>9.1</td>
<td>65.5</td>
<td>7.32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Baseline</td>
<td><img src="image1" alt="Left-Turn Display" /> <img src="image2" alt="Thru Display" /> <img src="image3" alt="Opposing Traffic" /> No Yield</td>
<td>44</td>
<td>13.6</td>
<td>65.9</td>
<td>9.1</td>
<td>11.4</td>
<td>65.9</td>
<td>8.86</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Baseline</td>
<td><img src="image1" alt="Left-Turn Display" /> <img src="image2" alt="Thru Display" /> <img src="image3" alt="Opposing Traffic" /> Yes Yield</td>
<td>130</td>
<td>6.9</td>
<td>83.8</td>
<td>6.2</td>
<td>3.1</td>
<td>83.8</td>
<td>8.54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Baseline</td>
<td><img src="image1" alt="Left-Turn Display" /> <img src="image2" alt="Thru Display" /> <img src="image3" alt="Opposing Traffic" /> No Yield</td>
<td>132</td>
<td>3.0</td>
<td>87.1</td>
<td>8.3</td>
<td>1.5</td>
<td>87.1</td>
<td>7.32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Baseline</td>
<td><img src="image1" alt="Left-Turn Display" /> <img src="image2" alt="Thru Display" /> <img src="image3" alt="Opposing Traffic" /> Yes Yield</td>
<td>137</td>
<td>13.1</td>
<td>70.8</td>
<td>8.0</td>
<td>8.0</td>
<td>70.8</td>
<td>7.64</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Baseline</td>
<td><img src="image1" alt="Left-Turn Display" /> <img src="image2" alt="Thru Display" /> <img src="image3" alt="Opposing Traffic" /> No Yield</td>
<td>123</td>
<td>16.3</td>
<td>66.7</td>
<td>8.9</td>
<td>8.1</td>
<td>66.7</td>
<td>8.63</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scenario</td>
<td>Type</td>
<td>Left-Turn Display</td>
<td>Thru Display</td>
<td>Opposing Traffic</td>
<td>Solution</td>
<td>Total Responses</td>
<td>Stop (%)</td>
<td>Yield (%)</td>
<td>Go (%)</td>
<td>IDK (%)</td>
<td>Correct (%)</td>
<td>Avg Time (sec)</td>
</tr>
<tr>
<td>----------</td>
<td>------------</td>
<td>-------------------</td>
<td>--------------</td>
<td>------------------</td>
<td>----------</td>
<td>----------------</td>
<td>----------</td>
<td>-----------</td>
<td>--------</td>
<td>---------</td>
<td>-------------</td>
<td>---------------</td>
</tr>
<tr>
<td>09a</td>
<td>Experimental</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td>Yes</td>
<td>Yield</td>
<td>158</td>
<td>1.9</td>
<td>86.7</td>
<td>8.9</td>
<td>2.5</td>
<td>86.7</td>
<td>7.40</td>
</tr>
<tr>
<td>09b</td>
<td>Experimental</td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td>Yes</td>
<td>Yield</td>
<td>201</td>
<td>4.0</td>
<td>86.6</td>
<td>7.0</td>
<td>2.5</td>
<td>86.6</td>
<td>7.26</td>
</tr>
<tr>
<td>10a</td>
<td>Experimental</td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
<td>No</td>
<td>Yield</td>
<td>129</td>
<td>0.8</td>
<td>84.5</td>
<td>10.9</td>
<td>3.9</td>
<td>84.5</td>
<td>7.33</td>
</tr>
<tr>
<td>10b</td>
<td>Experimental</td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
<td>No</td>
<td>Yield</td>
<td>170</td>
<td>3.5</td>
<td>84.1</td>
<td>8.2</td>
<td>4.1</td>
<td>84.1</td>
<td>8.72</td>
</tr>
<tr>
<td>11a</td>
<td>Experimental</td>
<td><img src="image9.png" alt="Image" /></td>
<td><img src="image10.png" alt="Image" /></td>
<td>Yes</td>
<td>Yield</td>
<td>148</td>
<td>18.2</td>
<td>70.3</td>
<td>6.8</td>
<td>4.7</td>
<td>70.3</td>
<td>9.44</td>
</tr>
<tr>
<td>11b</td>
<td>Experimental</td>
<td><img src="image11.png" alt="Image" /></td>
<td><img src="image12.png" alt="Image" /></td>
<td>Yes</td>
<td>Yield</td>
<td>190</td>
<td>18.4</td>
<td>70.0</td>
<td>5.3</td>
<td>6.3</td>
<td>70.0</td>
<td>8.33</td>
</tr>
<tr>
<td>12a</td>
<td>Experimental</td>
<td><img src="image13.png" alt="Image" /></td>
<td><img src="image14.png" alt="Image" /></td>
<td>No</td>
<td>Yield</td>
<td>135</td>
<td>11.1</td>
<td>76.3</td>
<td>7.4</td>
<td>5.2</td>
<td>76.3</td>
<td>8.00</td>
</tr>
<tr>
<td>12b</td>
<td>Experimental</td>
<td><img src="image15.png" alt="Image" /></td>
<td><img src="image16.png" alt="Image" /></td>
<td>No</td>
<td>Yield</td>
<td>172</td>
<td>16.9</td>
<td>71.5</td>
<td>5.2</td>
<td>6.4</td>
<td>71.5</td>
<td>7.81</td>
</tr>
<tr>
<td>13a</td>
<td>Experimental</td>
<td><img src="image17.png" alt="Image" /></td>
<td><img src="image18.png" alt="Image" /></td>
<td>Yes</td>
<td>Yield</td>
<td>141</td>
<td>12.1</td>
<td>73.8</td>
<td>6.4</td>
<td>7.8</td>
<td>73.8</td>
<td>8.23</td>
</tr>
<tr>
<td>13b</td>
<td>Experimental</td>
<td><img src="image19.png" alt="Image" /></td>
<td><img src="image20.png" alt="Image" /></td>
<td>Yes</td>
<td>Yield</td>
<td>183</td>
<td>11.5</td>
<td>68.3</td>
<td>9.8</td>
<td>10.4</td>
<td>68.3</td>
<td>8.79</td>
</tr>
<tr>
<td>14a</td>
<td>Experimental</td>
<td><img src="image21.png" alt="Image" /></td>
<td><img src="image22.png" alt="Image" /></td>
<td>No</td>
<td>Yield</td>
<td>132</td>
<td>15.9</td>
<td>67.4</td>
<td>7.6</td>
<td>9.1</td>
<td>67.4</td>
<td>7.94</td>
</tr>
<tr>
<td>14b</td>
<td>Experimental</td>
<td><img src="image23.png" alt="Image" /></td>
<td><img src="image24.png" alt="Image" /></td>
<td>No</td>
<td>Yield</td>
<td>176</td>
<td>19.3</td>
<td>60.8</td>
<td>8.5</td>
<td>11.4</td>
<td>60.8</td>
<td>6.97</td>
</tr>
<tr>
<td>Scenario</td>
<td>Type</td>
<td>Left-Turn Display</td>
<td>Thru Display</td>
<td>Opposing Traffic</td>
<td>Solution</td>
<td>Total Responses</td>
<td>Stop (%)</td>
<td>Yield (%)</td>
<td>Go (%)</td>
<td>IDK (%)</td>
<td>Correct (%)</td>
<td>Avg Time (sec)</td>
</tr>
<tr>
<td>----------</td>
<td>------------</td>
<td>-------------------</td>
<td>--------------</td>
<td>------------------</td>
<td>----------</td>
<td>----------------</td>
<td>----------</td>
<td>-----------</td>
<td>--------</td>
<td>---------</td>
<td>-------------</td>
<td>----------------</td>
</tr>
<tr>
<td>41a</td>
<td>Experimental</td>
<td>![Light]</td>
<td>![Light]</td>
<td>Yes</td>
<td>Yield</td>
<td>145</td>
<td>2.1</td>
<td>89.7</td>
<td>5.5</td>
<td>2.8</td>
<td>89.7</td>
<td>8.27</td>
</tr>
<tr>
<td>41b</td>
<td>Experimental</td>
<td>![Light]</td>
<td>![Light]</td>
<td>Yes</td>
<td>Yield</td>
<td>202</td>
<td>3.5</td>
<td>87.6</td>
<td>7.4</td>
<td>1.5</td>
<td>87.6</td>
<td>8.42</td>
</tr>
<tr>
<td>42a</td>
<td>Experimental</td>
<td>![Light]</td>
<td>![Light]</td>
<td>No</td>
<td>Yield</td>
<td>136</td>
<td>2.2</td>
<td>88.2</td>
<td>6.6</td>
<td>2.9</td>
<td>88.2</td>
<td>6.99</td>
</tr>
<tr>
<td>42b</td>
<td>Experimental</td>
<td>![Light]</td>
<td>![Light]</td>
<td>No</td>
<td>Yield</td>
<td>185</td>
<td>3.8</td>
<td>86.5</td>
<td>7.6</td>
<td>2.2</td>
<td>86.5</td>
<td>7.92</td>
</tr>
<tr>
<td>43a</td>
<td>Experimental</td>
<td>![Light]</td>
<td>![Light]</td>
<td>Yes</td>
<td>Yield</td>
<td>122</td>
<td>19.7</td>
<td>69.7</td>
<td>7.4</td>
<td>3.3</td>
<td>69.7</td>
<td>9.43</td>
</tr>
<tr>
<td>43b</td>
<td>Experimental</td>
<td>![Light]</td>
<td>![Light]</td>
<td>Yes</td>
<td>Yield</td>
<td>163</td>
<td>15.3</td>
<td>69.3</td>
<td>8.0</td>
<td>7.4</td>
<td>69.3</td>
<td>8.33</td>
</tr>
<tr>
<td>44a</td>
<td>Experimental</td>
<td>![Light]</td>
<td>![Light]</td>
<td>No</td>
<td>Yield</td>
<td>145</td>
<td>15.9</td>
<td>70.3</td>
<td>6.2</td>
<td>7.6</td>
<td>70.3</td>
<td>9.93</td>
</tr>
<tr>
<td>44b</td>
<td>Experimental</td>
<td>![Light]</td>
<td>![Light]</td>
<td>No</td>
<td>Yield</td>
<td>185</td>
<td>9.2</td>
<td>76.8</td>
<td>9.7</td>
<td>4.3</td>
<td>76.8</td>
<td>7.49</td>
</tr>
<tr>
<td>45a</td>
<td>Experimental</td>
<td>![Light]</td>
<td>![Light]</td>
<td>Yes</td>
<td>Yield</td>
<td>138</td>
<td>10.1</td>
<td>73.2</td>
<td>8.7</td>
<td>8.0</td>
<td>73.2</td>
<td>8.28</td>
</tr>
<tr>
<td>45b</td>
<td>Experimental</td>
<td>![Light]</td>
<td>![Light]</td>
<td>Yes</td>
<td>Yield</td>
<td>180</td>
<td>13.3</td>
<td>67.2</td>
<td>11.7</td>
<td>7.8</td>
<td>67.2</td>
<td>8.15</td>
</tr>
<tr>
<td>46a</td>
<td>Experimental</td>
<td>![Light]</td>
<td>![Light]</td>
<td>No</td>
<td>Yield</td>
<td>139</td>
<td>10.1</td>
<td>73.4</td>
<td>10.8</td>
<td>5.8</td>
<td>73.4</td>
<td>7.98</td>
</tr>
<tr>
<td>46b</td>
<td>Experimental</td>
<td>![Light]</td>
<td>![Light]</td>
<td>No</td>
<td>Yield</td>
<td>186</td>
<td>11.3</td>
<td>73.1</td>
<td>10.2</td>
<td>5.4</td>
<td>73.1</td>
<td>9.76</td>
</tr>
<tr>
<td>Scenario</td>
<td>Type</td>
<td>Left-Turn Display</td>
<td>Thru Display</td>
<td>Opposing Traffic</td>
<td>Solution</td>
<td>Total Responses</td>
<td>Stop (%)</td>
<td>Yield (%)</td>
<td>Go (%)</td>
<td>IDK (%)</td>
<td>Correct (%)</td>
<td>Avg Time (sec)</td>
</tr>
<tr>
<td>----------</td>
<td>---------------</td>
<td>-------------------</td>
<td>--------------</td>
<td>------------------</td>
<td>----------</td>
<td>----------------</td>
<td>----------</td>
<td>-----------</td>
<td>--------</td>
<td>---------</td>
<td>-------------</td>
<td>----------------</td>
</tr>
<tr>
<td>57a</td>
<td>Experimental</td>
<td>![Image]</td>
<td>![Image]</td>
<td>Yes</td>
<td>Yield</td>
<td>149</td>
<td>2.7</td>
<td>82.6</td>
<td>12.8</td>
<td>0.0</td>
<td>82.6</td>
<td>9.62</td>
</tr>
<tr>
<td>57b</td>
<td>Experimental</td>
<td>![Image]</td>
<td>![Image]</td>
<td>Yes</td>
<td>Yield</td>
<td>203</td>
<td>3.0</td>
<td>83.3</td>
<td>8.9</td>
<td>4.9</td>
<td>83.3</td>
<td>8.71</td>
</tr>
<tr>
<td>58a</td>
<td>Experimental</td>
<td>![Image]</td>
<td>![Image]</td>
<td>No</td>
<td>Yield</td>
<td>145</td>
<td>4.1</td>
<td>86.2</td>
<td>8.3</td>
<td>1.4</td>
<td>86.2</td>
<td>8.11</td>
</tr>
<tr>
<td>58b</td>
<td>Experimental</td>
<td>![Image]</td>
<td>![Image]</td>
<td>No</td>
<td>Yield</td>
<td>187</td>
<td>3.7</td>
<td>85.6</td>
<td>8.0</td>
<td>2.7</td>
<td>85.6</td>
<td>8.27</td>
</tr>
<tr>
<td>59a</td>
<td>Experimental</td>
<td>![Image]</td>
<td>![Image]</td>
<td>Yes</td>
<td>Yield</td>
<td>151</td>
<td>16.6</td>
<td>66.2</td>
<td>9.9</td>
<td>7.3</td>
<td>66.2</td>
<td>10.51</td>
</tr>
<tr>
<td>59b</td>
<td>Experimental</td>
<td>![Image]</td>
<td>![Image]</td>
<td>Yes</td>
<td>Yield</td>
<td>193</td>
<td>14.5</td>
<td>71.0</td>
<td>7.8</td>
<td>6.7</td>
<td>71.0</td>
<td>8.62</td>
</tr>
<tr>
<td>60a</td>
<td>Experimental</td>
<td>![Image]</td>
<td>![Image]</td>
<td>No</td>
<td>Yield</td>
<td>141</td>
<td>12.1</td>
<td>75.2</td>
<td>7.8</td>
<td>5.0</td>
<td>75.2</td>
<td>8.94</td>
</tr>
<tr>
<td>60b</td>
<td>Experimental</td>
<td>![Image]</td>
<td>![Image]</td>
<td>No</td>
<td>Yield</td>
<td>171</td>
<td>14.0</td>
<td>71.9</td>
<td>9.9</td>
<td>4.1</td>
<td>71.9</td>
<td>7.91</td>
</tr>
<tr>
<td>61a</td>
<td>Experimental</td>
<td>![Image]</td>
<td>![Image]</td>
<td>Yes</td>
<td>Yield</td>
<td>128</td>
<td>25.0</td>
<td>53.9</td>
<td>4.7</td>
<td>16.4</td>
<td>53.9</td>
<td>10.62</td>
</tr>
<tr>
<td>61b</td>
<td>Experimental</td>
<td>![Image]</td>
<td>![Image]</td>
<td>Yes</td>
<td>Yield</td>
<td>154</td>
<td>26.0</td>
<td>51.3</td>
<td>7.1</td>
<td>15.6</td>
<td>51.3</td>
<td>8.57</td>
</tr>
<tr>
<td>62a</td>
<td>Experimental</td>
<td>![Image]</td>
<td>![Image]</td>
<td>No</td>
<td>Yield</td>
<td>114</td>
<td>24.6</td>
<td>55.3</td>
<td>4.4</td>
<td>15.8</td>
<td>55.3</td>
<td>9.98</td>
</tr>
<tr>
<td>62b</td>
<td>Experimental</td>
<td>![Image]</td>
<td>![Image]</td>
<td>No</td>
<td>Yield</td>
<td>126</td>
<td>27.8</td>
<td>50.8</td>
<td>6.3</td>
<td>15.1</td>
<td>50.8</td>
<td>8.55</td>
</tr>
</tbody>
</table>
6.3. **Evaluation Data Set**

Data Set Column Names:

- Participant
- AgeGroup
- Gender
- DrivingExperience
- TimeToComplete
- Attempts
- QuestionPosition
- QuestionName
- ImageName
- Answer
- State
23-10-2013 20:39:51.283,6,M,3,8.426,1,12,42b,/g_exp/42b.gif,2, WI
23-10-2013 20:40:2.405,6,M,3,19.743,1,13,45b,/g_exp/45b.gif,3, WI
23-10-2013 20:40:24.518,6,M,3,6.566,1,14,13a,/g_exp/13a.gif,3, WI
23-10-2013 20:40:33.424,6,M,3,8.927,1,15,30,/g_cont/30.gif,3, WI
23-10-2013 20:48:26.468,4,F,3,14.626,1,1,60b,/g_exp/60b.gif,2, WI
23-10-2013 20:48:43.576,4,F,3,32.273,2,2,46a,/g_exp/46a.gif,2, WI
23-10-2013 20:49:18.884,4,F,3,17.004,1,3,42b,/g_exp/42b.gif,2, WI
23-10-2013 20:49:38.331,4,F,3,42.559,1,4,46b,/g_exp/46b.gif,3, WI
23-10-2013 20:50:22.688,4,F,3,15.667,1,5,54,/g_cont/54.jpg,1, WI
23-10-2013 20:50:40.785,4,F,3,13.432,1,6,23,/g_cont/23.jpg,1, WI
23-10-2013 20:50:56.577,4,F,3,13.881,1,7,17,/g_cont/17.gif,2, WI
23-10-2013 20:51:25.279,4,F,3,27.483,1,9,46b,/g_exp/46b.gif,2, WI
23-10-2013 20:51:56.368,4,F,3,26.865,1,10,56,/g_cont/56.jpg,1, WI
23-10-2013 20:52:25.276,4,F,3,18.439,1,11,13b,/g_exp/13b.gif,3, WI
23-10-2013 20:52:45.553,4,F,3,4.464,1,12,41b,/g_exp/41b.gif,2, WI
23-10-2013 20:52:51.836,4,F,3,80.111,1,13,22,/g_cont/22.gif,3, WI
23-10-2013 20:56:24.670,6,F,3,34.571,1,1,61b,/g_exp/61b.gif,3, WI
23-10-2013 20:57:2.592,6,F,3,46.94,2,2,29,/g_cont/29.gif,3, WI
23-10-2013 20:58:4.527,6,F,3,31.567,1,3,9b,/g_exp/9b.gif,2, WI
23-10-2013 20:58:39.497,6,F,3,32.699,1,4,45a,/g_exp/45a.gif,3, WI
23-10-2013 20:59:15.54,6,F,3,27.092,1,5,44b,/g_exp/44b.gif,2, WI
23-10-2013 20:59:45.232,6,F,3,32.088,1,6,45b,/g_exp/45b.gif,3, WI
23-10-2013 21:0:21.251,6,F,3,34.101,1,7,44a,/g_exp/44a.gif,2, WI
23-10-2013 21:0:58.245,6,F,3,13.418,1,8,4,/g_cont/4.jpg,2, WI
23-10-2013 21:1:1.891,6,F,3,8.179,1,9,13a,/g_exp/13a.gif,3, WI
23-10-2013 21:1:25.62,6,F,3,18.896,1,10,45b,/g_exp/45b.gif,3, WI
23-10-2013 21:1:52.518,6,F,3,15.861,1,11,36,/g_cont/36.jpg,2, WI
23-10-2013 21:2:10.452,6,F,3,17.303,1,12,25,/g_cont/25.gif,2, WI
23-10-2013 21:2:30.533,6,F,3,24.645,1,13,49,/g_cont/49.jpg,3, WI
23-10-2013 21:2:57.874,6,F,3,9.519,1,14,9a,/g_exp/9a.gif,2, WI
23-10-2013 21:3:10.38,6,F,3,13.656,1,15,50,/g_cont/50.jpg,2, WI
23-10-2013 21:3:25.870,6,F,3,6.975,1,16,13b,/g_exp/13b.gif,3, WI
23-10-2013 21:5:9.516,6,M,1,18.268,1,1,36,/g_cont/36.jpg,2, WI
23-10-2013 21:5:30.408,6,M,1,13.164,1,2,11b,/g_cont/11b.gif,2, WI
23-10-2013 21:5:45.359,6,M,1,8.865,1,3,50,/g_cont/50.jpg,2, WI
23-10-2013 21:5:59.802,6,M,1,13.972,1,4,21,/g_cont/21.gif,2, WI
23-10-2013 21:6:6.5,10,6,M,1,4.237,1,5,60b,/g_exp/60b.gif,2, WI
23-10-2013 21:6:10.504,6,M,1,4.085,1,6,46b,/g_exp/46b.gif,2, WI
23-10-2013 21:6:17.512,6,M,1,2.899,1,7,45a,/g_exp/45a.gif,2, WI
23-10-2013 21:6:22.188,6,M,1,2.818,1,8,11a,/g_exp/11a.gif,2, WI
23-10-2013 21:6:26.303,6,M,1,2.892,1,9,30,/g_cont/30.gif,2, WI
23-10-2013 21:6:30.728,6,M,1,1.93,1,10,39,/g_cont/39.jpg,2, WI
23-10-2013 21:6:35.518,6,M,1,2.369,1,11,44b,/g_exp/44b.gif,2, WI
23-10-2013 21:6:39.318,6,M,1,2.104,1,12,53,/g_cont/53.jpg,2, WI
23-10-2013 21:6:43.16,6,M,1,4.789,1,13,45b,/g_exp/45b.gif,2, WI
23-10-2013 21:6:50.175,6,M,1,2.849,1,14,9b,/g_exp/9b.gif,2, WI
23-10-2013 8:52:1.482,5,M,3,7.82,1,1,22,/g_cont/22.gif,2, WI
23-10-2013 8:52:11.935,5,M,3,11.48,1,2,43a,/g_exp/43a.gif,2, WI
23-10-2013 8:52:26.179,5,M,3,8.597,1,3,14a,/g_exp/14a.gif,2, WI
23-10-2013 8:52:36.398,5,M,3,14.839,1,4,21,/g_cont/21.gif,2, WI
23-10-2013 8:52:53.521,5,M,3,8.434,1,5,49,/g_cont/49.jpg,3, WI
23-10-2013 8:53:3.495,5,M,3,4.232,1,6,34,/g_cont/34.jpg,3, WI
23-10-2013 8:53:12.235,5,M,3,8.08,1,7,58b,/g_exp/58b.gif,2, WI
23-10-2013 7:31:8.7,l,F,1,19.584,1,8,43b,/g_exp/43b.gif,2,wi
23-10-2013 7:31:28.598,l,F,1,3.373,1,9,45b,/g_exp/45b.gif,2,wi
23-10-2013 7:31:33.141,l,F,1,7.441,1,10,43b,/g_cont/35.jpg,2,wi
23-10-2013 7:31:41.719,l,F,1,3.456,1,11,12b,/g_exp/12b.gif,2,wi
23-10-2013 7:31:47.309,l,F,1,5.296,1,12,33,/g_cont/33.jpg,3,wi
23-10-2013 7:31:53.570,l,F,1,4.288,1,13,38b,/g_exp/38b.gif,2,wi
23-10-2013 7:31:58.915,l,F,1,2.866,1,14,52,/g_cont/52.jpg,2,wi
23-10-2013 7:32:3.357,1,F,1,5.854,1,15,39b,/g_exp/39b.gif,2,wi
23-10-2013 7:50:12.417,6,M,3,50.811,1,1,10b,/g_exp/10b.gif,1,wi
23-10-2013 7:51:6.155,6,M,3,13.729,1,2,60b,/g_exp/60b.gif,1,wi
23-10-2013 7:51:22.29,6,M,3,8.931,1,3,55,/g_cont/55.jpg,1,wi
23-10-2013 7:51:34.222,6,M,3,29.833,1,4,45b,/g_exp/45b.gif,1,wi
23-10-2013 7:52:6.6,6,M,3,41.505,1,5,41b,/g_exp/41b.gif,1,wi
23-10-2013 7:52:49.179,6,M,3,6.544,1,6,31,/g_cont/31.jpg,1,wi
23-10-2013 7:52:58.527,6,M,3,21.057,1,7,25,/g_l/25.gif,1,wi
23-10-2013 7:53:20.924,6,M,3,11.636,1,8,17,/g_l/17.gif,1,wi
23-10-2013 7:53:34.196,6,M,3,4.014,1,9,60a,/g_exp/60a.gif,1,wi
23-10-2013 7:53:39.541,6,M,3,4.076,1,10,36,/g_cont/36.jpg,1,wi
23-10-2013 7:53:57.184,6,M,3,8.731,1,11,7,/g_cont/7.jpg,1,wi
23-10-2013 7:54:6.837,6,M,3,6.501,1,12,42b,/g_exp/42b.gif,1,wi
23-10-2013 7:54:16.387,6,M,3,9.552,1,13,14b,/g_exp/14b.gif,1,wi
23-10-2013 8:5:28.253,5,M,3,13.045,1,2,32,/g_cont/32.jpg,3,wi
23-10-2013 8:5:44.164,5,M,3,11.25,1,3,24,/g_cont/24.jpg,3,wi
23-10-2013 8:5:58.370,5,M,3,30.244,1,4,9b,/g_exp/9b.gif,2,wi
23-10-2013 8:6:32.497,5,M,3,17.307,1,5,41b,/g_exp/41b.gif,2,wi
23-10-2013 8:6:53.828,5,M,3,22.967,1,6,45b,/g_exp/45b.gif,2,wi
23-10-2013 8:7:19.793,5,M,3,33.22,1,7,10b,/g_exp/10b.gif,2,wi
23-10-2013 8:7:55.259,5,M,3,20.702,1,8,43a,/g_exp/43a.gif,2,wi
23-10-2013 8:8:17.912,5,M,3,21.605,1,9,17,/g_l/17.gif,2,wi
23-10-2013 8:8:41.711,5,M,3,19.167,1,10,22,/g_l/22.gif,2,wi
23-10-2013 8:9:3.224,5,M,3,12.046,1,11,43b,/g_exp/43b.gif,2,wi
23-10-2013 8:9:17.185,5,M,3,9.835,1,12,49,/g_cont/49.jpg,3,wi
23-10-2013 8:9:28.971,5,M,3,12.165,1,13,58b,/g_exp/58b.gif,2,wi
23-10-2013 8:33:10.768,4,F,3,16.925,1,1,58b,/g_exp/58b.gif,2,wi
23-10-2013 8:33:29.462,4,F,3,34.843,2,2,61b,/g_exp/61b.gif,2,wi
23-10-2013 8:34:5.555,4,F,3,11.066,1,3,41a,/g_exp/41a.gif,2,wi
23-10-2013 8:34:18.543,4,F,3,4.694,1,4,1,/g_cont/1.jpg,3,wi
23-10-2013 8:34:27.403,4,F,3,5.611,1,5,41b,/g_exp/41b.gif,2,wi
23-10-2013 8:34:36.419,4,F,3,7.265,1,6,58a,/g_exp/58a.gif,2,wi
23-10-2013 8:34:44.934,4,F,3,3.943,1,7,14b,/g_exp/14b.gif,2,wi
23-10-2013 8:34:50.696,4,F,3,7.62,1,8,41b,/g_exp/41b.gif,2,wi
23-10-2013 8:34:59.831,4,F,3,4.979,1,9,30,/g_l/30.gif,2,wi
23-10-2013 8:35:6.243,4,F,3,3.74,1,10,51,/g_cont/51.jpg,2,wi
23-10-2013 8:35:11.609,4,F,3,3.14,1,11,32,/g_cont/32.jpg,3,wi
23-10-2013 8:35:16.944,4,F,3,2.438,1,12,21,/g_l/21.gif,2,wi
23-10-2013 8:35:20.583,4,F,3,3.15,1,13,5,/g_cont/5.jpg,2,wi
23-10-2013 8:35:24.952,4,F,3,2.49,1,14,10b,/g_exp/10b.gif,2,wi
23-10-2013 9:27:29.546,2,M,3,18.368,1,1,30,/g_l/30.gif,2,wi
23-10-2013 9:27:50.699,2,M,3,8.855,1,2,9b,/g_exp/9b.gif,2,wi
23-10-2013 9:28:2.662,2,M,3,10.455,1,3,41b,/g_exp/41b.gif,2,wi
23-10-2013 9:28:15.250,2,M,3,6.329,1,4,29,/g_l/29.gif,2,wi
23-10-2013 9:28:23.83,2,M,3,5.404,1,5,61b,/g_exp/61b.gif,2,wi
23-10-2013 9:28:30.347,2,M,3,14.495,1,6,50,/g_cont/50.jpg,3,wi
23-10-2013 9:28:46.60,2,M,3,6.805,2,7,10b,/g_exp/10b.gif,2,wi
<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>ID</th>
<th>Value</th>
<th>Type</th>
<th>State</th>
<th>Location</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-10-2013</td>
<td>10:43</td>
<td>53.758,4,F,3,4.614,1,7,41b</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:44</td>
<td>0.340,4,F,3,8.349,1,8,59a</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:44</td>
<td>11.265,4,F,3,2.812,1,9,41a</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:44</td>
<td>14.968,4,F,3,2.999,1,10,42a</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:44</td>
<td>19.676,4,F,3,2.578,1,11,46b</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:44</td>
<td>23.238,4,F,3,3.75,1,12,32</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:44</td>
<td>27.973,4,F,3,4.109,1,13,59b</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:44</td>
<td>36.82,4,F,3,9.693,1,14,14b</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:44</td>
<td>47.150,4,F,3,3.5,1,15,4</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:53</td>
<td>22.562,1,F,1,9.969,1,1,6</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:53</td>
<td>33.202,1,F,1,7.196,1,2,59a</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:53</td>
<td>42.898,1,F,1,6.859,1,3,26</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:53</td>
<td>50.687,1,F,1,5.221,1,4,12a</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:53</td>
<td>56.924,1,F,1,10.504,2,3,45b</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:54</td>
<td>7.845,1,F,1,5.364,1,6,9b</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:54</td>
<td>14.69,1,F,1,8.218,1,7,21</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:54</td>
<td>22.834,1,F,1,2.547,1,8,19</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:54</td>
<td>27.100,1,F,1,5.203,1,9,13b</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:54</td>
<td>32.897,1,F,1,7.172,1,10,59b</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:54</td>
<td>41.865,1,F,1,13.103,2,11,44b</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:54</td>
<td>55.946,1,F,1,2.559,1,12,9a</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:54</td>
<td>59.465,1,F,1,4.107,1,13,45a</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:55</td>
<td>4.60,1,F,1,9.823,1,14,49</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:55</td>
<td>15.8,1,F,1,6.312,1,15,12b</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-10-2013</td>
<td>10:55</td>
<td>21.992,1,F,1,7.094,1,16,40</td>
<td>b.gif</td>
<td>12a</td>
<td>F</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
04:40.9,5,F,1,2.896,1,18,62a,\text{/g\_exp/62a.gif},2,\text{WI}
04:40.9,5,F,3,56.853,1,2,57b,\text{/g\_exp/57b.gif},2,\text{WI}
04:16.4,5,F,3,20.733,1,1,42b,\text{/g\_exp/42b.gif},2,\text{WI}
04:16.4,5
04:16.4,5
17-10-2013 14:32:52.764,1,M,110.181,1,1,24,/g_cont/24.jpg,3,MA
17-10-2013 14:33:4.18,1,M,1.6.741,1,2,14b,/g_exp/14b.gif,2,MA
17-10-2013 14:33:11.974,1,M,17.926,1,3,16,/g_cont/16.jpg,3,MA
17-10-2013 14:33:20.634,1,M,1.4.238,1,4,18,/g_l/18.gif,2,MA
17-10-2013 14:33:26.165,1,M,1.10.075,1,5,29,/g_l/29.gif,2,MA
17-10-2013 14:33:37.54,1,M,1.4.487,1,6,13b,/g_exp/13b.gif,2,MA
17-10-2013 14:33:42.416,1,M,1.7.976,1,7,49,/g_cont/49.jpg,3,MA
17-10-2013 14:33:51.360,1,M,1.4.111,1,8,13a,/g_exp/13a.gif,2,MA
17-10-2013 14:33:57.16,1,M,1.2.579,1,9,57b,/g_exp/57b.gif,2,MA
17-10-2013 14:34:0.795,1,M,1.4.588,1,10,44b,/g_exp/44b.gif,2,MA
17-10-2013 14:34:6.827,1,M,1.2.251,1,11,22,/g_l/22.gif,2,MA
17-10-2013 14:34:10.297,1,M,12.51,1,12,61b,/g_exp/61b.gif,2,MA
17-10-2013 14:34:13.809,1,M,1.6.164,1,13,53,/g_cont/53.jpg,2,MA
17-10-2013 14:34:20.877,1,M,1.2.831,1,14,15,/g_cont/15.jpg,1,MA
17-10-2013 14:34:24.716,1,M,1.2.767,1,15,12b,/g_exp/12b.gif,2,MA
17-10-2013 14:34:28.491,1,M,1.2.104,1,16,12a,/g_exp/12a.gif,2,MA
17-10-2013 14:34:31.472,1,M,1.5.656,1,17,50,/g_cont/50.jpg,3,MA
17-10-2013 14:34:38.200,1,M,1.3.08,1,18,38,/g_cont/38.jpg,2,MA
17-10-2013 14:34:42.216,1,M,1.2.709,1,19,61a,/g_exp/61a.gif,2,MA
17-10-2013 14:34:45.831,1,M,1.1.961,1,20,60b,/g_exp/60b.gif,2,MA
17-10-2013 14:34:48.685,1,M,1.3.687,1,21,42b,/g_exp/42b.gif,2,MA
17-10-2013 14:34:53.401,1,M,1.2.31,1,22,26,/g_l/26.gif,2,MA
17-10-2013 14:34:56.619,1,M,1.2.409,1,23,10a,/g_exp/10a.gif,2,MA
17-10-2013 14:34:59.856,1,M,1.1.812,1,24,59b,/g_exp/59b.gif,2,MA
17-10-2013 14:35:2.414,1,M,1.5.308,2,25,62b,/g_exp/62b.gif,2,MA
17-10-2013 14:35:9.253,1,M,1.3.414,1,26,13b,/g_exp/13b.gif,2,MA
17-10-2013 14:35:13.427,1,M,1.3.647,1,27,10b,/g_exp/10b.gif,2,MA
17-10-2013 14:35:17.771,1,M,1.3.423,1,28,3,/g_cont/3.jpg,2,MA
17-10-2013 14:36:51.376,1,M,1.1.15,12,1,1,22,/g_l/22.gif,2,MA
17-10-2013 14:37:9.501,1,M,1.10.107,1,2,57a,/g_exp/57a.gif,2,MA
17-10-2013 14:37:24.896,1,M,1.7.902,1,3,41b,/g_exp/41b.gif,2,MA
17-10-2013 14:37:34.734,1,M,1.3.83,1,4,5,/g_cont/5.jpg,1,MA
17-10-2013 14:37:40.330,1,M,1.2.448,1,5,27,/g_cont/27.gif,1,MA
17-10-2013 14:37:43.799,1,M,1.8.328,1,6,6,/g_cont/6.jpg,1,MA
17-10-2013 14:37:54.2,1,M,1.31.256,3,7,43a,/g_exp/43a.gif,1,MA
17-10-2013 14:38:26.137,1,M,1.7.345,1,8,29,/g_l/29.gif,2,MA
17-10-2013 14:38:54.4,1,M,1.2.246,1,9,58b,/g_exp/58b.gif,2,MA
17-10-2013 14:38:56.891,1,M,1.13.795,2,10,12b,/g_exp/12b.gif,4,MA
17-10-2013 14:39:11.108,1,M,1.2.766,1,11,63,/g_cont/63.jpg,1,MA
17-10-2013 14:39:14.764,1,M,1.3.047,1,12,57b,/g_exp/57b.gif,2,MA
17-10-2013 14:39:18.608,1,M,1.11.976,3,13,40,/g_cont/40.jpg,3,MA
17-10-2013 14:39:31.443,1,M,1.2.479,1,14,25,/g_l/25.gif,3,MA
17-10-2013 14:39:34.470,1,M,1.2.743,1,15,54,/g_cont/54.jpg,3,MA
17-10-2013 14:39:38.901,1,M,1.5.943,2,16,57b,/g_exp/57b.gif,3,MA
6.4. R Code

6.4.1. FYA_InputData.R

##
## FYA Analysis
## Dan Reichl & Mark Banghart
##
# Load Libraries
#
library(car)
library(leaps)  # for leaps()
library(nlme)   # for lme() mixed models balanced
library(lme4)   # for lmer() mixed models balanced
library(faraway) # for Cpplot()
library(DAAG)   # for cross validation cv.lm
library(alr3)   # for ridge regression lm.ridge
library(pls)    # for pls (partial least squares regression)
library("grid") # ggplot uses this library
library(ggplot2) # ggplot
library(plyr)   # for the "." function used with ggplot subset
library(scales)  # Used with ggplot
library(MASS)
library(reshape2) # for melt
library(boot)   # for glm.diag.plot
library(lattice) # Used with binom
library(binom)

## Input the data
#
##
### Load the WI data files
data.wi <- read.csv(file="Data/WI.csv", header=TRUE, sep=" ","
data.wi["State"] <- "WI"
data.wi$State <- as.factor(data.wi$State)
str(data.wi)

### Load the MA data files
data.ma <- read.csv(file="Data/MA.csv", header=TRUE, sep=" ","
data.ma["State"] <- "MA"
data.ma$State <- as.factor(data.ma$State)
#str(data.ma)

####### Combine the data into one data frame
data.all.1 <- rbind(data.wi, data.ma)
data.all.2 <- data.all.1[,c(2,3,4,8,10,11),drop=FALSE]
colnames(data.all.2) <- c("Age","Gender","Experience","Question","Response","State")
#str(data.all.2)

####### Add Labels for Age Groups
age.labels <- c("18-24", "25-34", "35-44", "45-54", "55-64", "65-74", "75+")
data.all.2["Age"] <- factor(data.all.2$Age, labels = age.labels)
#str(data.all.2)

####### Add Labels for Driving Experience
exp.labels <- c("<5", "5-10", ">10")
data.all.2["Experience"] <- factor(data.all.2$Experience,
                                   labels = exp.labels)
#str(data.all.2)

####### Import Variables Associated with Question Name
#
#  Type
#  "B" - "Baseline"
#  "C" - "Control"
#  "E" - "Experiment"
#
#  Arrangement
#  "3SV" - "3 Section Vertical"
#  "4SV" - "4 Section Vertical"
#  "4SH" - "4 Section Horizontal"
#  "5SC" - "5 Section Clustered"
#  "5SS" - "5 Section Clustered with Simultaneous Display"
#
#  LT.Indication
#  "RA" - "Red Arrow"
#  "YA" - "Yellow Arrow"
#  "GA" - "Green Arrow"
#  "FM" - "FYA - Middle Section"
#  "FB" - "FYA - Bottom Section"
#  "NO" - "No Arrow"
#
#  TH.Indication
#  "R" - "CR"
#  "Y" - "CY"
#  "G" - "CG"
#
#  Traffic
# "Y" - "Yes"
# "N" - "No"
# Correct number
# Critical number

```r
var.map <- matrix(c(
  "1", "01", "C", "3SV", "GA", "R", "Y", "3", "0",
  "2", "02", "C", "3SV", "GA", "G", "Y", "3", "0",
  "3", "03", "C", "3SV", "YA", "G", "Y", "1", "3",
  "4", "04", "C", "3SV", "YA", "G", "N", "1", "3",
  "5", "05", "C", "3SV", "YA", "Y", "Y", "1", "3",
  "6", "06", "C", "3SV", "YA", "R", "Y", "1", "3",
  "7", "07", "C", "3SV", "YA", "R", "N", "1", "3",
  "8", "08", "C", "3SV", "YA", "R", "N", "1", "3",
  "9a", "09a", "E", "3SV", "FB", "G", "Y", "2", "3",
  "9b", "09b", "E", "3SV", "FM", "G", "Y", "2", "3",
  "10a", "10a", "E", "3SV", "FB", "G", "N", "2", "3",
  "10b", "10b", "E", "3SV", "FB", "G", "N", "2", "3",
  "11a", "11a", "E", "3SV", "FB", "Y", "Y", "2", "3",
  "12a", "12a", "E", "3SV", "FB", "Y", "N", "2", "3",
  "12b", "12b", "E", "3SV", "FB", "Y", "N", "2", "3",
  "13a", "13a", "E", "3SV", "FB", "R", "Y", "2", "3",
  "13b", "13b", "E", "3SV", "FB", "R", "Y", "2", "3",
  "14a", "14a", "E", "3SV", "FB", "R", "N", "2", "3",
  "14b", "14b", "E", "3SV", "FB", "R", "N", "2", "3",
  "15", "15", "C", "3SV", "RA", "R", "Y", "1", "3",
  "16", "16", "C", "3SV", "GA", "G", "N", "3", "0",
  "17", "17", "B", "4SV", "FY", "G", "Y", "2", "3",
  "19", "19", "B", "4SV", "FY", "Y", "Y", "2", "3",
  "20", "20", "B", "4SV", "FY", "Y", "N", "2", "3",
  "21", "21", "B", "4SV", "FY", "R", "Y", "2", "3",
  "22", "22", "B", "4SV", "FY", "R", "N", "2", "3",
  "23", "23", "C", "4SV", "RA", "R", "Y", "1", "3",
  "29", "29", "B", "4SH", "FY", "R", "Y", "2", "3",
  "31", "31", "C", "4SH", "RA", "R", "Y", "1", "3",
  "33", "33", "C", "5SC", "GA", "R", "Y", "3", "0",
  "34", "34", "C", "5SC", "GA", "G", "Y", "3", "0",
  "35", "35", "C", "5SC", "YA", "G", "Y", "1", "3",
  "37", "37", "C", "5SC", "YA", "Y", "Y", "1", "3",
), sep = "", nrow = 37)``````
```
rownames(var.map) <- var.val <- nr <- length(data.all.2)
nc <- ncol(var.map)

var.val <- matrix( rep("", nr*nc), ncol=nc)
rownames(var.map) <- var.map[,1]

for (i in 1:length(data.all.2,"Question")) {
  var.val[i,] <- var.map[as.character(data.all.2[i,"Question"])],]
}
```
#str(var.val)

data.all.3 <- data.frame(
    data.all.2,
    Scenario=var.val[,2],
    Type=var.val[,3],
    Arrangement=var.val[,4],
    LT.Indication=var.val[,5],
    TH.Indication=var.val[,6],
    Traffic=var.val[,7],
    Correct=(data.all.2[,"Response"]==var.val[,8]),
    fCritical=(data.all.2[,"Response"]==var.val[,9]),
    fSafe = (data.all.2[,"Response"]!=var.val[,8] &
      data.all.2[,"Response"]!=var.val[,9]),
    Go=(data.all.2[,"Response"]==3),
    Yield=(data.all.2[,"Response"]==2),
    Stop=(data.all.2[,"Response"]==1),
    IDK=(data.all.2[,"Response"]==4))

##### Edit Age Groups
data.all.3 <- within(data.all.3, levels(Age)
  [levels(Age)="25-34" | levels(Age)="35-44"] <- "25-44")
data.all.3 <- within(data.all.3, levels(Age)
  [levels(Age)="45-54" | levels(Age)="55-64"] <- "45-64")
data.all.3 <- within(data.all.3, levels(Age)
  [levels(Age)="65-74" | levels(Age)="75+"] <- "65+")

##### Rename Data Frame and Remove Unnecessary Data
df <- data.all.3
#str(df)
rm(data.all.1, data.all.2, data.all.3, data.ma, data.wi,
   var.map, var.val, age.labels, exp.labels, i, nc, nr, saved.dir)
6.4.2. FYA_CtPrConvert.R

##
## FYA Analysis
## Dan Reichl & Mark Banghart
##

# Convert Data to Counts and Proportions
#

##### Generate Column Names for Variables being Analyzed
ct.col <- test[ which( test != "FALSE")]
cnum <- length(ct.col) + 1
col[ct.num] <- "Num"

##### Generate List for Variables being Analyzed
if (ct.num==2) {
  ct.list <- list(df[,ct.col[1]])
}
if (ct.num==3) {
  ct.list <- list(df[,ct.col[1]], df[,ct.col[2]])
}
if (ct.num==4) {
}
if (ct.num==5) {
                  df[,ct.col[4]])
}
if (ct.num==6) {
                  df[,ct.col[4]], df[,ct.col[5]])
}
if (ct.num==7) {
                  df[,ct.col[7]])
}
if (ct.num==8) {
                  df[,ct.col[7]], df[,ct.col[8]])
}
if (ct.num==9) {
                  df[,ct.col[7]], df[,ct.col[8]], df[,ct.col[9]])
}
if (ct.num==10) {
                  df[,ct.col[10]])

}
if (ct.num==11) {
  df[,ct.col[10]])}

##### Obtain Counts/Proportions of Correct & Fail-Critical Responses

df.correct <- aggregate( df[,"Correct"], by=ct.list, FUN=sum)
colnames(df.correct) <- ct.col

df.fail <- aggregate( !df,"Correct"), by=ct.list, FUN=sum)
colnames(df.fail) <- ct.col

df.fcritical <- aggregate( df[,"fCritical"], by=ct.list, FUN=sum)
colnames(df.fcritical) <- ct.col

df.fsafe <- aggregate( df[,"fSafe"], by=ct.list, FUN=sum)
colnames(df.fsafe) <- ct.col

ct.correct <-
  rbind( data.frame( df.correct[,1:ct.num],
    Total= (df.correct[,"Num"] + df.fail[,"Num"]),
    Response = rep("Correct",nrow(df.correct)) ),
  data.frame( df.fcritical[,1:ct.num],
    Total= (df.correct[,"Num"] + df.fail[,"Num"]),
    Response = rep("fCritical",nrow(df.fcritical)) ),
  data.frame( df.fsafe[,1:ct.num],
    Total= (df.correct[,"Num"] + df.fail[,"Num"]),
    Response = rep("fSafe",nrow(df.fsafe)) )

a.pr.correct <-
  data.frame(ct.correct,
    binom.confint( ct.correct[,"Num"],
      ct.correct[,"Total"],
      conf.level = 0.95,
      methods = "wilson" )
  ,[,4:6] )
colnames(a.pr.correct)[match("mean",names(a.pr.correct))] <-
  "Proportion"

##### Obtain Counts & Proportions of Stop, Yield, Go Responses

df.go <- aggregate( df[,"Go"], by=ct.list, FUN=sum)
colnames(df.go) <- ct.col

df.yield <- aggregate( df[,"Yield"], by=ct.list, FUN=sum)
colnames(df.yield) <- ct.col

df.stop <- aggregate( df[,"Stop"], by=ct.list, FUN=sum)
colnames(df.stop) <- ct.col
df.idk <- aggregate( df[,"IDK"], by=ct.list, FUN=sum)
colnames(df.idk) <- ct.col

c.t.response <-
  rbind( data.frame( df.go[,1:ct.num],
                   Total= (df.correct[,"Num"] + df.fail[,"Num"],
                   Response = rep("Go",nrow(df.go)) ),
    data.frame( df.yield[,1:ct.num],
                   Total= (df.correct[,"Num"] + df.fail[,"Num"],
                   Response = rep("Yield",nrow(df.yield)) ),
    data.frame( df.stop[,1:ct.num],
                   Total= (df.correct[,"Num"] + df.fail[,"Num"],
                   Response = rep("Stop",nrow(df.stop)) ),
    data.frame( df.idk[,1:ct.num],
                   Total= (df.correct[,"Num"] + df.fail[,"Num"],
                   Response = rep("IDK",nrow(df.idk)) ) )

a.pr.response <-
data.frame(ct.response,
  binom.confint( ct.response[,"Num"],
                 ct.response[,"Total"],
                 conf.level = 0.95,
                 methods = "wilson" )
  [,4:6] )
colnames(a.pr.response)[match("mean",names(a.pr.response))] <-
  "Proportion"

rm(ct.col, ct.list, ct.num)
6.4.3. FYA_Plots.R

##
## FYA Analysis
## Dan Reichl & Mark Banghart
##
# Plot: Signal Display Comparison: Correct
# Display_Correct.png (475 x 350)
#
# Convert Data to Counts and Proportions
source("FYA_CtPrConvert.R")

##### Create Vector for Variables
test <- vector(length=10)

##### Variables to Analyze
# test[1] <- "Scenario"
test[2] <- "Arrangement"
test[3] <- "LT.Indication"
# test[4] <- "TH.Indication"
test[5] <- "Traffic"
test[6] <- "Gender"
test[7] <- "Age"
test[8] <- "Experience"
test[9] <- "State"
test[10] <- "Type"

##### Combine Data into Table for Plot
Tbl <- a.pr.correct
Tbl <- Tbl[Tbl$Response=="Correct" & Tbl$Type=="E",]
Tbl <- droplevels(Tbl)

##### Create Plot
Plot <-
  ggplot(Tbl, aes(x=Arrangement, y=Proportion*100,
                 fill=LT.Indication,
                 ymin=lower*100, ymax=upper*100)) +
  geom_bar(stat = "identity", position="dodge",
           width=0.80, colour="black") +
  facet_grid(.~State) +
  geom_errorbar(width=0.25,
                size=0.75, position=position_dodge(width=0.80)) +
  geom_text(aes(label=format(round(Proportion*100, digits=1),
                  nsmall=1),
             y=42.5, fontface="bold"), size=3.5,
position=position_dodge(width=0.80)) +

# X-Axis Labels: Level 1
geom_text(data=data.frame(1),
aes(x="3SV", y=40, label="3-Section\nVertical"),
size=3.75, colour="black", inherit.aes=FALSE,
parse=FALSE, y=37) +
geom_text(data=data.frame(1),
aes(x="5Sc", y=40, label="5-Section\nClustered"),
size=3.75, colour="black", inherit.aes=FALSE,
parse=FALSE, y=37) +
geom_text(data=data.frame(1),
aes(x="5Ss", y=40, label="5-Section\nSimultaneous"),
size=3.75, colour="black", inherit.aes=FALSE,
parse=FALSE, y=37) +

# X-Axis Labels: Level 2
geom_text(data=data.frame(1),
aes(x=2, y=40, label=c("Wisconsin","Massachusetts")),
size=5, colour="black", inherit.aes=FALSE,
parse=FALSE, y=30) +

# X-Axis Settings
theme(panel.grid.major.x = element_line(colour=NA)) +
theme(axis.title.x = element_blank()) +
theme(axis.text.x = element_blank()) +
theme(axis.ticks.x = element_blank()) +

# Y-Axis Settings
scale_y_continuous(limits = c(40,100),
breaks=seq(40,100,by=10),
oob = squish) +
theme(axis.title.y = element_blank()) +
theme(axis.text.y = element_text(colour="black")) +
theme(axis.ticks.y = element_line(colour="black")) +
theme(axis.ticks.length = unit(0.25, "cm")) +
theme(panel.grid.major.y = element_line(colour="gray")) +
theme(panel.grid.minor.y = element_line(colour=NA)) +

# General Formatting
theme(plot.margin = unit(c(0,0.25,2,0.25), "lines")) +
theme(panel.margin=unit(0, "cm")) +
theme(panel.background = element_blank()) +
theme(strip.background = element_blank()) +
theme(strip.text = element_blank()) +
theme(legend.position="none") +
scale_fill_manual(values=c("gray90", "gray52")) +

# Lines: X-Axis Level 1
annotation_custom(grob = linesGrob(),
xmin = 1.5, xmax = 1.5, ymin = 34, ymax = 40)+
annotation_custom(grob = linesGrob(),
xmin = 2.5, xmax = 2.5, ymin = 34, ymax = 40)+
# Lines: X-Axis Level 2
annotation_custom(grob = linesGrob(),
xmin = 0.4, xmax = 0.4, ymin = 28, ymax = 100)+
annotation_custom(grob = linesGrob(),
xmin = 3.6, xmax = 3.6, ymin = 28, ymax = 100)+

# Lines: Y-Axis Border
annotation_custom(grob = linesGrob(),
xmin = 0.4, xmax = 3.6, ymin = 40, ymax = 40)+
annotation_custom(grob = linesGrob(),
xmin = 0.4, xmax = 3.6, ymin = 100, ymax = 100)

##### Save Plot
gt <- ggplot_gtable(ggplot_build(Plot))
gt$layout$clip[gt$layout$name=="panel"] <- "off"
png(file = "Excel/Plots/Display_Correct.png", height=350, width=475)
grid.draw(gt)
dev.off()

##################################################################
##################################################################
##   Plot: Signal Display Comparison: Fail Critical
##   Display_Fail.png (475 x 350)
##   ##################################################################

##### Create Vector for Variables
test <- vector(length=10)

##### Variables to Analyze
#test[1] <- "Scenario"
test[2] <- "Arrangement"
test[3] <- "LT.Indication"
#test[4] <- "TH.Indication"
#test[5] <- "Traffic"
#test[6] <- "Gender"
#test[7] <- "Age"
#test[8] <- "Experience"
test[9] <- "State"
test[10] <- "Type"

##### Convert Data to Counts and Proportions
source("FYA_CtPrConvert.R")

##### Combine Data into Table for Plot
Tbl <- a.pr.correct
Tbl <- Tbl[
    Tbl$Response="fCritical" &
    Tbl$Type="E",]
Tbl <- droplevels(Tbl)
# Create Plot

Plot <-

# Input Data
ggplot(Tbl, aes(x=Arrangement, y=Proportion*100, fill=LT.Indication, ymin=lower*100, ymax=upper*100)) +
geom_bar(stat = "identity", position="dodge", width=0.80, colour="black") +
facet_grid(~State) +
geom_errorbar(width=0.25, size=0.75, position=position_dodge(width=0.80)) +
geom_text(aes(label=format(round(Proportion*100, digits=1), nsmall=1), y=1.5, fontface="bold"), size=3.5, position=position_dodge(width=0.80)) +

# X-Axis Labels: Level 1
geom_text(data=data.frame(1),
aes(x="3SV", y=0, label="3-Section\nVertical"), size=3.75, colour="black", inherit.aes=FALSE, parse=FALSE, y=-1.5) +
geom_text(data=data.frame(1),
aes(x="5SS", y=0, label="5-Section\nSimultaneous"), size=3.75, colour="black", inherit.aes=FALSE, parse=FALSE, y=-1.5) +

# X-Axis Labels: Level 2
geom_text(data=data.frame(1),
aes(x=2, y=0, label=c("Wisconsin", "Massachusetts")), size=5, colour="black", inherit.aes=FALSE, parse=FALSE, y=-5) +

# X-Axis Settings
theme(panel.grid.major.x = element_line(colour=NA)) +
theme(axis.title.x = element_blank()) +
theme(axis.text.x = element_blank()) +
theme(axis.ticks.x = element_blank()) +
theme(axis.ticks.length = unit(0.25, "cm")) +
theme(panel.grid.major.y = element_line(colour="gray")) +
theme(panel.grid.minor.y = element_line(colour=NA)) +

# Y-Axis Settings
scale_y_continuous(limits = c(0,30),
    breaks=seq(0,30,by=10), oob = squish) +
theme(axis.title.y = element_blank()) +
theme(axis.text.y = element_text(colour="black")) +
theme(axis.ticks.y = element_line(colour="black")) +
theme(axis.ticks.length = unit(0.25, "cm")) +
theme(panel.grid.major.y = element_line(colour="gray")) +
theme(panel.grid.minor.y = element_line(colour=NA)) +

# General Formatting
theme(plot.margin = unit(c(0,0.25,2,0.25), "lines")) +
theme(panel.margin=unit(0,"cm")) +
theme(panel.background = element_blank()) +
theme(strip.background = element_blank()) +
theme(strip.text = element_blank()) +
theme(legend.position="none") +
scale_fill_manual(values=c("gray90", "gray52")) +

# Lines: X-Axis Level 1
annotation_custom(grob = linesGrob(),
  xmin = 1.5, xmax = 1.5, ymin = -3, ymax = 0) +
annotation_custom(grob = linesGrob(),
  xmin = 2.5, xmax = 2.5, ymin = -3, ymax = 0) +

# Lines: X-Axis Level 2
annotation_custom(grob = linesGrob(),
  xmin = 0.4, xmax = 0.4, ymin = -6, ymax = 30) +
annotation_custom(grob = linesGrob(),
  xmin = 3.6, xmax = 3.6, ymin = -6, ymax = 30) +

# Lines: Y-Axis Border
annotation_custom(grob = linesGrob(),
  xmin = 0.4, xmax = 3.6, ymin = 0, ymax = 0) +
annotation_custom(grob = linesGrob(),
  xmin = 0.4, xmax = 3.6, ymin = 30, ymax = 30)

##### Save Plot
gt <- ggplot_gtable(ggplot_build(Plot))
gt$layout$clip[gt$layout$name=="panel"] <- "off"
png(file = "Excel/Plots/Display_Fail.png", height=350, width=475)
grid.draw(gt)
dev.off()

#################################################################
##   Plot: Signal Display Comparison: Base
##   Display_Comparison.png (600 x 400)
#################################################################

##### Create Vector for Variables
test <- vector(length=10)

#### Variables to Analyze
#test[1] <- "Scenario"
test[2] <- "Arrangement"
#test[3] <- "LT.Indication"
#test[4] <- "TH.Indication"
#test[5] <- "Traffic"
#test[6] <- "Gender"
#test[7] <- "Age"
# Convert Data to Counts and Proportions
source("FYA_CtPrConvert.R")

# Combine Data into Table for Plot
Tbl <- a.pr.correct
Tbl <- Tbl[Tbl$Response=="Correct" &
        Tbl$Arrangement!="4SH" &
        Tbl$Type!="C" ,]
Tbl <- droplevels(Tbl)

# Re-Order Factors for Plot
Tbl$Arrangement <- factor(Tbl$Arrangement,levels =
c("4SV","3SV","5SC","5SS"))

# Create Plot
Plot <-
  ggplot(Tbl, aes(x=Arrangement, y=Proportion*100,
        ymin=lower*100, ymax=upper*100)) +
  geom_bar(stat = "identity", position="dodge", width=0.65,
        fill="gray65", colour="black") +
  facet_grid(.~State) +
  geom_errorbar(width=0.25,
        size=0.75, position=position_dodge(width=0.65)) +
  geom_text(aes(label=format(round(Proportion*100,digits=1),
        nsmall=1),
        y=42.5, fontface="bold"), size=3.5,
        position=position_dodge(width=0.65)) +

  # X-Axis Labels: Level 1
  geom_text(data=data.frame(1),
        aes(x="3SV", y=40, label="3-Section\nVertical"),
        size=3.75, colour="black", inherit.aes=FALSE,
        parse=FALSE,y=37) +
  geom_text(data=data.frame(1),
        aes(x="5Sc", y=40, label="5-Section\nClustered"),
        size=3.75, colour="black", inherit.aes=FALSE,
        parse=FALSE,y=37) +
  geom_text(data=data.frame(1),
        aes(x="5SS", y=40, label="5-Section\nSimultaneous"),
        size=3.75, colour="black", inherit.aes=FALSE,
        parse=FALSE,y=37) +
  geom_text(data=data.frame(1),
        aes(x="4SV", y=40, label="4-Section\nVertical"),
        size=3.75, colour="black", inherit.aes=FALSE,
        parse=FALSE,y=37) +

  # X-Axis Labels: Level 2
  geom_text(data=data.frame(1),
dev.off()

# Create Vector for Variables
test <- vector(length=10)

# Variables to Analyze
#test[1] <- "Scenario"
#test[2] <- "Arrangement"
test[3] <- "LT.Indication"
test[4] <- "TH.Indication"
#test[5] <- "Traffic"
#test[6] <- "Gender"
#test[7] <- "Age"
#test[8] <- "Experience"
test[9] <- "State"
test[10] <- "Type"

# Convert Data to Counts and Proportions
source("FYA_CtPrConvert.R")

# Combine Data into Table for Plot
Tbl <- a.pr.correct
Tbl <- Tbl[Tbl$Response=="Correct" & Tbl$Type=="E",]

# Re-Order Factors for Plot
Tbl$TH.Indication <- factor(Tbl$TH.Indication, levels = c("G","Y","R"))

# Create Plot
Plot <-
ggplot(Tbl, aes(x=TH.Indication, y=Proportion*100, fill=LT.Indication, ymin=lower*100, ymax=upper*100)) +
geom_bar(stat = "identity", position="dodge", width=0.80, colour="black") +
facets(.~State) +
geom_errorbar(width=0.25, size=0.75, position=position_dodge(width=0.80)) +
geom_text(aes(label=format(round(Proportion*100, digits=1), nsmall=1),
# Lines: X-Axis Level 2
annotation_custom(grob = linesGrob(),
    xmin = 0.4, xmax = 0.4, ymin = 28, ymax = 100)+
annotation_custom(grob = linesGrob(),
    xmin = 3.6, xmax = 3.6, ymin = 28, ymax = 100)+

# Lines: Y-Axis Border
annotation_custom(grob = linesGrob(),
    xmin = 0.4, xmax = 3.6, ymin = 40, ymax = 40)+
annotation_custom(grob = linesGrob(),
    xmin = 0.4, xmax = 3.6, ymin = 100, ymax = 100)

##### Save Plot
gt <- ggplot_gtable(ggplot_build(Plot))
gt$layout$clip[gt$layout$name=="panel"] <- "off"
png(file = "Excel/Plots/Thru_Correct.png", height=350, width=475)
grid.draw(gt)
dev.off()
##### Re-Order Factors for Plot

```r
Tbl$TH.Indication <- factor(Tbl$TH.Indication, levels = c("G", "Y", "R"))
```

##### Create Plot

```r
Plot <-
# Input Data
ggplot(Tbl, aes(x=TH.Indication, y=Proportion*100, fill=LT.Indication, 
            ymin=lower*100, ymax=upper*100)) +
geom_bar(stat = "identity", position="dodge", 
            width=0.80, colour="black") +
facet_grid(.~State) +
geom_errorbar(width=0.25, 
             size=0.75, position=position_dodge(width=0.80)) +
geom_text(aes(label=format(round(Proportion*100, digits=1), nsmall=1), 
             y=2, fontface="bold"), size=3.5, 
             position=position_dodge(width=0.80)) +

# X-Axis Labels: Level 1
geom_text(data=data.frame(1), 
          aes(x="G", y=0, label="Circular\nGreen"),
          size=3.75, colour="black", inherit.aes=FALSE, 
          parse=FALSE,y=-1.5) +
geom_text(data=data.frame(1), 
          aes(x="Y", y=0, label="Circular\nYellow"),
          size=3.75, colour="black", inherit.aes=FALSE, 
          parse=FALSE,y=-1.5) +
geom_text(data=data.frame(1), 
          aes(x="R", y=0, label="Circular\nRed"),
          size=3.75, colour="black", inherit.aes=FALSE, 
          parse=FALSE,y=-1.5) +

# X-Axis Labels: Level 2
geom_text(data=data.frame(1), 
          aes(x=2, y=0, label=c("Wisconsin","Massachusetts")),
          size=5, colour="black", inherit.aes=FALSE, 
          parse=FALSE,y=-5) +

# X-Axis Settings
theme(panel.grid.major.x = element_line(colour=NA)) +
theme(axis.title.x = element_blank()) +
theme(axis.text.x = element_blank()) +
theme(axis.ticks.x = element_blank()) +

# Y-Axis Settings
scale_y_continuous(limits = c(0,30),
                   breaks=seq(0,30,by=10),
                   oob = squish) +
theme(axis.title.y = element_blank()) +
theme(axis.text.y = element_text(colour="black")) +
theme(axis.ticks.y = element_line(colour="black")) +
```
theme(axis.ticks.length = unit(0.25, "cm")) +
theme(panel.grid.major.y = element_line(colour="gray")) +
theme(panel.grid.minor.y = element_line(colour=NA)) +

# General Formatting
theme(plot.margin = unit(c(0,0.25,2,0.25), "lines")) +
theme(panel.margin=unit(0,"cm")) +
theme(panel.background = element_blank()) +
theme(strip.background = element_blank()) +
theme(strip.text = element_blank()) +
theme(legend.position="none") +
scale_fill_manual(values=c("gray90", "gray52")) +

# Lines: X-Axis Level 1
annotation_custom(grob = linesGrob(),
     xmin = 1.5, xmax = 1.5, ymin = -3, ymax = 0)+
annotation_custom(grob = linesGrob(),
     xmin = 2.5, xmax = 2.5, ymin = -3, ymax = 0)+

# Lines: X-Axis Level 2
annotation_custom(grob = linesGrob(),
     xmin = 0.4, xmax = 0.4, ymin = -6, ymax = 30)+
annotation_custom(grob = linesGrob(),
     xmin = 3.6, xmax = 3.6, ymin = -6, ymax = 30)+

# Lines: Y-Axis Border
annotation_custom(grob = linesGrob(),
     xmin = 0.4, xmax = 3.6, ymin = 0, ymax = 0)+
annotation_custom(grob = linesGrob(),
     xmin = 0.4, xmax = 3.6, ymin = 30, ymax = 30)

##### Save Plot
gt <- ggplot_gtable(ggplot_build(Plot))
gt$layout$clip[gt$layout$name=="panel"] <- "off"
png(file = "Excel/Plots/Thru_Fail.png", height=350, width=475)
grid.draw(gt)
dev.off()
test[3] <- "LT.Indication"
test[4] <- "TH.Indication"
#test[5] <- "Traffic"
#test[6] <- "Gender"
#test[7] <- "Age"
#test[8] <- "Experience"
test[9] <- "State"
test[10] <- "Type"

##### Convert Data to Counts and Proportions
source("FYA_CtPrConvert.R")

##### Combine Data into Table for Plot
Tbl <- a.pr.correct
Tbl <- Tbl[
  Tbl$Response=="Correct" &
  Tbl$Type=="E" &
  Tbl$State=="WI",]
Tbl <- droplevels(Tbl)

##### Re-Order Factors for Plot
Tbl$TH.Indication <- factor(Tbl$TH.Indication,levels =
  c("G","Y","R"))

##### Create Plot
Plot <-
  # Input Data
ggplot(Tbl, aes(x=Arrangement, y=Proportion*100, fill=LT.Indication,
            ymin=lower*100, ymax=upper*100)) +
  geom_bar(stat = "identity", position="dodge",
            width=0.80, colour="black") +
  facet_grid(.~TH.Indication) +
  geom_errorbar(width=0.25,
                size=0.75, position=position_dodge(width=0.80)) +
  geom_text(aes(label=format(round(Proportion*100,digits=1),
                  nsmall=1),
            y=42.5, fontface="bold"), size=3.5,
            position=position_dodge(width=0.80)) +

  # X-Axis Labels: Level 1
  geom_text(data=data.frame(1,
    aes(x="3SV", y=40, label="3-Section\nVertical"),
    size=3.75, colour="black", inherit.aes=FALSE,
    parse=FALSE,y=37) +
  geom_text(data=data.frame(1,
    aes(x="5Sc", y=40, label="5-Section\nClustered"),
    size=3.75, colour="black", inherit.aes=FALSE,
    parse=FALSE,y=37) +
  geom_text(data=data.frame(1,
    aes(x="5SS", y=40, label="5-Section\nSimultaneous"),
    size=3.75, colour="black", inherit.aes=FALSE,
    parse=FALSE,y=37) +
## X-Axis Labels: Level 2
```r
gtext(data=data.frame(1),
   aes(x=2, y=40, label=c("CG", 
                           "CY", 
                           "CR")),
   size=5, colour="black", inherit.aes=FALSE,
   parse=FALSE,y=30) +
```

## X-Axis Settings
```r
theme(panel.grid.major.x = element_line(colour=NA)) +
theme(axis.title.x = element_blank()) +
theme(axis.text.x = element_blank()) +
theme(axis.ticks.x = element_blank()) +
```

## Y-Axis Settings
```r
scale_y_continuous(limits = c(40,100),
   breaks=seq(40,100,by=10),
   oob = squish) +
theme(axis.title.y = element_blank()) +
theme(axis.text.y = element_blank()) +
theme(axis.ticks.y = element_line(colour="black")) +
theme(axis.ticks.length = unit(0.25, "cm")) +
theme(panel.grid.major.y = element_line(colour="gray")) +
theme(panel.grid.minor.y = element_line(colour=NA)) +
```

## General Formatting
```r
theme(plot.margin = unit(c(0,0.25,2,0.25), "lines")) +
theme(panel.margin=unit(0,"cm")) +
theme(panel.background = element_blank()) +
theme(strip.background = element_blank()) +
theme(strip.text = element_blank()) +
theme(legend.position="none") +
scale_fill_manual(values=c("gray90", "gray52")) +
```

## Lines: X-Axis Level 1
```r
annotation_custom(grob = linesGrob(),
   xmin = 1.5, xmax = 1.5, ymin = 34, ymax = 40)+
```

## Lines: X-Axis Level 2
```r
annotation_custom(grob = linesGrob(),
   xmin = 0.4, xmax = 0.4, ymin = 28, ymax = 100)+
```

## Lines: Y-Axis Border
```r
annotation_custom(grob = linesGrob(),
   xmin = 0.4, xmax = 3.6, ymin = 40, ymax = 40)+
```

#### Save Plot
```
gt <- ggplot_gtable(ggplot_build(Plot))
```
gt$layout$clip[gt$layout$name=="panel"] <- "off"
png(file = "Excel/Plots/Display & Thru.png", height=450, width=750)
grid.draw(gt)
dev.off()

##### Create Vector for Variables
test <- vector(length=10)

##### Variables to Analyze
#test[1] <- "Scenario"
#test[2] <- "Arrangement"
test[3] <- "LT.Indication"
#test[4] <- "TH.Indication"
test[5] <- "Traffic"
#test[6] <- "Gender"
#test[7] <- "Age"
#test[8] <- "Experience"
test[9] <- "State"
test[10] <- "Type"

##### Convert Data to Counts and Proportions
source("FYA_CtPrConvert.R")

##### Combine Data into Table for Plot
Tbl <- a.pr.correct
Tbl <- Tbl[
    Tbl$Response=="Correct" &
    Tbl$Type=="E" ,]
Tbl <- droplevels(Tbl)

##### Create Plot
Plot <-
# Input Data
ggplot(Tbl, aes(x=Traffic, y=Proportion*100, fill=LT.Indication,
    ymin=lower*100, ymax=upper*100)) +
geom_bar(stat = "identity", position="dodge",
    width=0.80, colour="black") +
facet_grid(.~State) +
geom_errorbar(width=0.25,
    size=0.75, position=position_dodge(width=0.80)) +
geom_text(aes(label=format(round(Proportion*100,digits=1),
        nsmall=1),
    y=42.5, fontface="bold"), size=3.5,
    position=position_dodge(width=0.80)) +
# X-Axis Labels: Level 1
geom_text(data=data.frame(1),
aes(x="Y", y=40, label="Yes"),
  size=3.75, colour="black", inherit.aes=FALSE,
  parse=FALSE,y=37) +
geom_text(data=data.frame(1),
aes(x="N", y=40, label="No"),
  size=3.75, colour="black", inherit.aes=FALSE,
  parse=FALSE,y=37) +

# X-Axis Labels: Level 2
geom_text(data=data.frame(1),
aes(x=1.5, y=40, label=c("Wisconsin","Massachusetts")),
  size=5, colour="black", inherit.aes=FALSE,
  parse=FALSE,y=30) +

# X-Axis Settings
theme(panel.grid.major.x = element_line(colour=NA)) +
theme(axis.title.x = element_blank()) +
theme(axis.text.x = element_blank()) +
theme(axis.ticks.x = element_blank()) +

# Y-Axis Settings
scale_y_continuous(limits = c(40,100),
  breaks=seq(40,100,by=10),
  oob = squish) +
theme(axis.title.y = element_blank()) +
theme(axis.text.y = element_text(colour="black")) +
theme(axis.ticks.y = element_line(colour="black")) +
theme(axis.ticks.length = unit(0.25, "cm")) +
theme(panel.grid.major.y = element_line(colour="gray")) +
theme(panel.grid.minor.y = element_line(colour=NA)) +

# General Formatting
theme(plot.margin = unit(c(0.0,0.25,2,0.25), "lines")) +
theme(panel.margin=unit(0,"cm")) +
theme(panel.background = element_blank()) +
theme(strip.background = element_blank()) +
theme(strip.text = element_blank()) +
theme(legend.position="none") +
scale_fill_manual(values=c("gray90", "gray52")) +

# Lines: X-Axis Level 1
annotation_custom(grob = linesGrob(),
  xmin = 1.5, xmax = 1.5, ymin = 34, ymax = 40)+

# Lines: X-Axis Level 2
annotation_custom(grob = linesGrob(),
  xmin = 0.4, xmax = 0.4, ymin = 28, ymax = 100)+
  annotation_custom(grob = linesGrob(),
  xmin = 2.6, xmax = 2.6, ymin = 28, ymax = 100)+

# Lines: Y-Axis Border
##### Create Vector for Variables

test <- vector(length=10)

##### Variables to Analyze
#test[1] <- "Scenario"
#test[2] <- "Arrangement"
test[3] <- "LT.Indication"
#test[4] <- "TH.Indication"
#test[5] <- "Traffic"
test[6] <- "Gender"
#test[7] <- "Age"
#test[8] <- "Experience"
test[9] <- "State"
test[10] <- "Type"

##### Convert Data to Counts and Proportions
source("FYA_CtPrConvert.R")

##### Combine Data into Table for Plot
Tbl <- a.pr.correct
Tbl <- Tbl[  
  Tbl$Response=="Correct" &  
  Tbl$Type=="E" ,]
Tbl <- droplevels(Tbl)

##### Create Plot
Plot <-  
  # Input Data  
  ggplot(Tbl, aes(x=Gender, y=Proportion*100, fill=LT.Indication,  
               ymin=lower*100, ymax=upper*100)) +  
  geom_bar(stat = "identity", position="dodge",  
             width=0.80, colour="black") +
facet_grid(.~State) +
geom_errorbar(width=0.25,
  size=0.75, position=position_dodge(width=0.80)) +
geom_text(aes(label=format(round(Proportion*100,digits=1),
  nsmall=1),
  y=42.5, fontface="bold"), size=3.5,
  position=position_dodge(width=0.80)) +

# X-Axis Labels: Level 1
geom_text(data=data.frame(1), aes(x="M", y=40, label="Male"),
  size=3.75, colour="black", inherit.aes=FALSE,
  parse=FALSE,y=37) +
geom_text(data=data.frame(1), aes(x="F", y=40, label="Female"),
  size=3.75, colour="black", inherit.aes=FALSE,
  parse=FALSE,y=37) +

# X-Axis Settings
theme(panel.grid.major.x = element_line(colour=NA)) +
theme(axis.title.x = element_blank()) +
theme(axis.text.x = element_blank()) +
theme(axis.ticks.x = element_blank()) +

# Y-Axis Settings
scale_y_continuous(limits = c(40,100),
  breaks=seq(40,100,by=10),
  oob = squish) +
theme(axis.title.y = element_blank()) +
theme(axis.text.y = element_text(colour="black")) +
theme(axis.ticks.y = element_line(colour="black")) +
theme(axis.ticks.length = unit(0.25, "cm")) +
theme(panel.grid.major.y = element_line(colour="gray")) +
theme(panel.grid.minor.y = element_line(colour=NA)) +

# General Formatting
theme(plot.margin = unit(c(0,0.25,2,0.25), "lines")) +
theme(panel.margin=unit(0,"cm")) +
theme(panel.background = element_blank()) +
theme(strip.background = element_blank()) +
theme(strip.text = element_blank()) +
theme(legend.position="none") +
scale_fill_manual(values=c("gray90", "gray52")) +

# Lines: X-Axis Level 1
annotation_custom(grob = linesGrob(),
  xmin = 1.5, xmax = 1.5, ymin = 34, ymax = 40)+

# Lines: X-Axis Level 2
annotation_custom(grob = linesGrob(),
##### Create Vector for Variables

test <- vector(length=10)

##### Variables to Analyze
#test[1] <- "Scenario"
#test[2] <- "Arrangement"
test[3] <- "LT.Indication"
#test[4] <- "TH.Indication"
#test[5] <- "Traffic"
#test[6] <- "Gender"
#test[7] <- "Age"
test[8] <- "Experience" 
test[9] <- "State"
test[10] <- "Type"

##### Convert Data to Counts and Proportions
source("FYA_CtPrConvert.R")

##### Combine Data into Table for Plot
Tbl <- a.pr.correct
Tbl <- Tbl[
  Tbl$Response="Correct" & Tbl$Type="E",
]
Tbl <- droplevels(Tbl)

##### Create Plot
Plot <-
# Input Data

```r
ggplot(Tbl, aes(x=Experience, y=Proportion*100, fill=LT.Indication, ymin=lower*100, ymax=upper*100)) +
geom_bar(stat = "identity", position="dodge", width=0.80, colour="black") +
facet_grid(.~State) +
geom_errorbar(width=0.25, size=0.75, position=position_dodge(width=0.80)) +
geom_text(aes(label=format(round(Proportion*100, digits=1), nsmall=1), y=42.5, fontface="bold"), size=3.5, position=position_dodge(width=0.80)) +

# X-Axis Labels: Level 1
geom_text(data=data.frame(1),
  aes(x="<5", y=40, label="<5"),
  size=3.75, colour="black", inherit.aes=FALSE, parse=FALSE, y=37) +
geom_text(data=data.frame(1),
  aes(x="5-10", y=40, label="5-10"),
  size=3.75, colour="black", inherit.aes=FALSE, parse=FALSE, y=37) +
geom_text(data=data.frame(1),
  aes(x=">10", y=40, label=">10"),
  size=3.75, colour="black", inherit.aes=FALSE, parse=FALSE, y=37) +

# X-Axis Labels: Level 2
geom_text(data=data.frame(1),
  aes(x=2, y=40, label=c("Wisconsin","Massachusetts")),
  size=5, colour="black", inherit.aes=FALSE, parse=FALSE, y=30) +

# X-Axis Settings
theme(panel.grid.major.x = element_line(colour=NA)) +
theme(axis.title.x = element_blank()) +
theme(axis.text.x = element_blank()) +
theme(axis.ticks.x = element_blank()) +
theme(axis.ticks.length = unit(0.25, "cm")) +
theme(panel.grid.major.y = element_line(colour="gray")) +
theme(panel.grid.minor.y = element_line(colour=NA)) +

# Y-Axis Settings
scale_y_continuous(limits = c(40,100),
  breaks=seq(40,100,by=10),
  oob = squish) +
theme(axis.title.y = element_blank()) +
theme(axis.text.y = element_blank()) +
theme(axis.ticks.y = element_blank()) +
theme(axis.ticks.length = unit(0.25, "cm")) +
theme(panel.grid.major.y = element_line(colour="gray")) +
theme(panel.grid.minor.y = element_line(colour=NA)) +

# General Formatting
theme(plot.margin = unit(c(0,0.25,2,0.25), "lines")) +
theme(panel.margin=unit(0, "cm")) +
```

```r
theme(panel.background = element_blank()) +
theme(strip.background = element_blank()) +
theme(strip.text = element_blank()) +
theme(legend.position="none") +
scale_fill_manual(values=c("gray90", "gray52")) +

# Lines: X-Axis Level 1
annotation_custom(grob = linesGrob(),
    xmin = 1.5, xmax = 1.5, ymin = 34, ymax = 40)+
annotation_custom(grob = linesGrob(),
    xmin = 2.5, xmax = 2.5, ymin = 34, ymax = 40)+

# Lines: X-Axis Level 2
annotation_custom(grob = linesGrob(),
    xmin = 0.4, xmax = 0.4, ymin = 28, ymax = 100)+
annotation_custom(grob = linesGrob(),
    xmin = 3.6, xmax = 3.6, ymin = 28, ymax = 100)+

# Lines: Y-Axis Border
annotation_custom(grob = linesGrob(),
    xmin = 0.4, xmax = 3.6, ymin = 40, ymax = 40)+
annotation_custom(grob = linesGrob(),
    xmin = 0.4, xmax = 3.6, ymin = 100, ymax = 100)

##### Save Plot
gt <- ggplot_gtable(ggplot_build(Plot))
gt$layout$clip[gt$layout$name=="panel"] <- "off"
png(file = "Excel/Plots/Experience_Correct.png",height=350,width=475)
grid.draw(gt)
dev.off()

##################################################################

##### Create Vector for Variables
test <- vector(length=10)

##### Variables to Analyze
#test[1] <- "Scenario"
#test[2] <- "Arrangement"
test[3] <- "LT.Indication"
#test[4] <- "TH.Indication"
#test[5] <- "Traffic"
#test[6] <- "Gender"
test[7] <- "Age"
#test[8] <- "Experience"
test[9] <- "State"
```
test[10] <- "Type"

##### Convert Data to Counts and Proportions
source("FYA_CtPrConvert.R")

##### Combine Data into Table for Plot
Tbl <- a.pr.correct
Tbl <- Tbl[
    Tbl$Response=="Correct" &
    Tbl$Type=="E",
]
Tbl <- droplevels(Tbl)

##### Create Plot
Plot <-
    # Input Data
    ggplot(Tbl, aes(x=Age, y=Proportion*100, fill=LT.Indication,
                      ymin=lower*100, ymax=upper*100)) +
    geom_bar(stat = "identity", position="dodge",
             width=0.80, colour="black") +
    facet_grid(.~State) +
    geom_errorbar(width=0.25,
                  size=0.75, position=position_dodge(width=0.80)) +
    geom_text(aes(label=format(round(Proportion*100, digits=1),
                     nsmall=1),
               y=43, fontface="bold"), size=3.5,
               position=position_dodge(width=0.80)) +

    # X-Axis Labels: Level 1
    geom_text(data=data.frame(1),
                aes(x="18-24", y=40, label="18-24"),
                size=3.75, colour="black", inherit.aes=FALSE,
                parse=FALSE,y=37) +
    geom_text(data=data.frame(1),
                aes(x="25-44", y=40, label="25-44"),
                size=3.75, colour="black", inherit.aes=FALSE,
                parse=FALSE,y=37) +
    geom_text(data=data.frame(1),
                aes(x="45-64", y=40, label="45-64"),
                size=3.75, colour="black", inherit.aes=FALSE,
                parse=FALSE,y=37) +
    geom_text(data=data.frame(1),
                aes(x="65+", y=40, label="65+") ,
                size=3.75, colour="black", inherit.aes=FALSE,
                parse=FALSE,y=37) +

    # X-Axis Labels: Level 2
    geom_text(data=data.frame(1),
                aes(x=2.5, y=40, label=c("Wisconsin","Massachusetts")),
                size=5, colour="black", inherit.aes=FALSE,
                parse=FALSE,y=30) +

    # X-Axis Settings
    theme(panel.grid.major.x = element_line(colour=NA)) +
    theme(axis.title.x = element_blank()) +
theme(axis.text.x = element_blank()) +
theme(axis.ticks.x = element_blank()) +

# Y-Axis Settings
scale_y_continuous(limits = c(40,100),
                   breaks=seq(40,100,by=10),
                   oob = squish) +
theme(axis.title.y = element_blank()) +
theme(axis.text.y = element_text(colour="black")) +
theme(axis.ticks.y = element_line(colour="black")) +
theme(axis.ticks.length = unit(0.25, "cm")) +
theme(panel.grid.major.y = element_line(colour="gray")) +
theme(panel.grid.minor.y = element_line(colour=NA)) +

# General Formatting
theme(plot.margin = unit(c(0,0.25,2,0.25), "lines")) +
theme(panel.margin=unit(0,"cm")) +
theme(panel.background = element_blank()) +
theme(strip.background = element_blank()) +
theme(strip.text = element_blank()) +
theme(legend.position="none") +
scale_fill_manual(values=c("gray90", "gray52")) +

# Lines: X-Axis Level 1
annotation_custom(grob = linesGrob(),
                   xmin = 1.5, xmax = 1.5, ymin = 34, ymax = 40)+
annotation_custom(grob = linesGrob(),
                   xmin = 2.5, xmax = 2.5, ymin = 34, ymax = 40)+
annotation_custom(grob = linesGrob(),
                   xmin = 3.5, xmax = 3.5, ymin = 34, ymax = 40)+

# Lines: X-Axis Level 2
annotation_custom(grob = linesGrob(),
                   xmin = 0.4, xmax = 0.4, ymin = 28, ymax = 100)+
annotation_custom(grob = linesGrob(),
                   xmin = 4.6, xmax = 4.6, ymin = 28, ymax = 100)+

# Lines: Y-Axis Border
annotation_custom(grob = linesGrob(),
                   xmin = 0.4, xmax = 4.6, ymin = 40, ymax = 40)+
annotation_custom(grob = linesGrob(),
                   xmin = 0.4, xmax = 4.6, ymin = 100, ymax = 100)

#### Save Plot
gt <- ggplot_gtable(ggplot_build(Plot))
gt$layout$clip[gt$layout$name=="panel"] <- "off"
png(file = "Excel/Plots/Age_Correct.png", height=400, width=600)
grid.draw(gt)
dev.off()
### Plot: All Scenarios: Separated by State and Signal Display
### Scenarios_WI-3SV.png (475 x 350)

########################################################################
########################################################################

#### Create Vector for Variables
```r
test <- vector(length=10)

#test[1] <- "Scenario"
test[2] <- "Arrangement"
test[3] <- "LT.Indication"
test[4] <- "TH.Indication"
test[5] <- "Traffic"
#test[6] <- "Gender"
#test[7] <- "Age"
#test[8] <- "Experience"
test[9] <- "State"
test[10] <- "Type"
```

#### Convert Data to Counts and Proportions
```r
source("FYA_CtPrConvert.R")
```

#### Combine Data into Table for Plot
```
Tbl <- a.pr.correct
Tbl <- Tbl[Tbl$Response=="Correct" &
            Tbl$Type=="E" &
            Tbl$Arrangement=="3SV" &
            Tbl$State=="WI",]
Tbl <- droplevels(Tbl)
```

#### Re-Order Factors for Plot
```
Tbl$TH.Indication <- factor(Tbl$TH.Indication,levels = c("G","Y","R"))
```

#### Create Plot
```
Plot <-
# Input Data
ggplot(Tbl, aes(x=Traffic, y=Proportion*100, fill=LT.Indication,
            ymin=lower*100, ymax=upper*100)) +
geom_bar(stat = "identity", position="dodge",
            width=0.80, colour="black") +
facet_grid(.~TH.Indication) +
geom_errorbar(width=0.25,
            size=0.75, position=position_dodge(width=0.80)) +
geom_text(aes(label=format(round(Proportion*100,digits=1),nsmall=1),
            y=42.5, fontface="bold"), size=3.5,
            position=position_dodge(width=0.80)) +

# X-Axis Labels: Level 1
geom_text(data=data.frame(1),
aes(x="Y", y=40, label="Yes"),
```

```r
```
size=3.75, colour="black", inherit.aes=FALSE, parse=FALSE,y=37) +
geom_text(data=data.frame(1),
aes(x="N", y=40, label="No"),
size=3.75, colour="black", inherit.aes=FALSE, parse=FALSE,y=37) +

# X-Axis Labels: Level 1
geom_text(data=data.frame(1),
aes(x=1.5, y=40, label=c("CG", "CY", "CR")),
size=4.5, colour="black", inherit.aes=FALSE, parse=FALSE,y=30) +

# X-Axis Settings
theme(panel.grid.major.x = element_line(colour=NA)) +
theme(axis.title.x = element_blank()) +
theme(axis.text.x = element_blank()) +
theme(axis.ticks.x = element_blank()) +

# Y-Axis Settings
scale_y_continuous(limits = c(40,100),
breaks=seq(40,100,by=10),
oob = squish) +
theme(axis.title.y = element_blank()) +
theme(axis.text.y = element_text(colour="black")) +
theme(axis.ticks.y = element_line(colour="black")) +
theme(axis.ticks.length = unit(0.25, "cm")) +
theme(panel.grid.major.y = element_line(colour="gray")) +
theme(panel.grid.minor.y = element_line(colour=NA)) +

# General Formatting
theme(plot.margin = unit(c(0,0.25,2,0.25), "lines")) +
theme(panel.margin=unit(0,"cm")) +
theme(panel.background = element_blank()) +
theme(strip.background = element_blank()) +
theme(strip.text = element_blank()) +
theme(Legend.position="none") +
scale_fill_manual(values=c("gray90", "gray52")) +

# Lines: X-Axis Level 1
annotation_custom(grob = linesGrob(),
  xmin = 1.5, xmax = 1.5, ymin = 34, ymax = 40) +

# Lines: X-Axis Level 2
annotation_custom(grob = linesGrob(),
  xmin = 0.4, xmax = 0.4, ymin = 28, ymax = 40) +
annotation_custom(grob = linesGrob(),
  xmin = 2.6, xmax = 2.6, ymin = 28, ymax = 40) +

# Lines: Y-Axis Border
annotation_custom(grob = linesGrob(),
  xmin = 0.4, xmax = 2.6, ymin = 40, ymax = 40) +
### Variables to Analyze

```r
test[1] <- "Scenario"
test[2] <- "Arrangement"
test[3] <- "LT.Indication"
test[4] <- "TH.Indication"
test[5] <- "Traffic"
test[6] <- "Gender"
test[7] <- "Age"
test[8] <- "Experience"
test[9] <- "State"
test[10] <- "Type"
```

### Convert Data to Counts and Proportions

```r
source("FYA_CtPrConvert.R")
```

### Combine Data into Table for Plot

```r
Tbl <- a.pr.correct
Tbl <- Tbl[  Tbl$Response=="Correct" &
             Tbl$Type=="E" &
             Tbl$Arrangement=="5SC" &
             Tbl$State=="WI",]  # Switch between 3SV, 5SC, 5SS
# Switch between WI, MA
Tbl <- droplevels(Tbl)
```

### Re-Order Factors for Plot

```r
Tbl$TH.Indication <- factor(Tbl$TH.Indication,levels =
                           c("G","Y","R"))
```

### Create Plot

```r
Plot <-
```
ggplot(Tbl, aes(x=Traffic, y=Proportion*100, fill=LT.Indication, 
          ymin=lower*100, ymax=upper*100)) +
geom_bar(stat = "identity", position="dodge", 
          width=0.80, colour="black") +
facet_grid(~TH.Indication) +
geom_errorbar(width=0.25, 
          size=0.75, position=position_dodge(width=0.80)) +
geom_text(aes(label=format(round(Proportion*100,digits=1), 
                      nsmall=1), 
          y=42.5, fontface="bold"), size=3.5, 
          position=position_dodge(width=0.80)) +

# X-Axis Labels: Level 1
geom_text(data=data.frame(1), aes(x="Y", y=40, label="Yes"), 
          size=3.75, colour="black", inherit.aes=FALSE, 
          parse=FALSE,y=37) +
geom_text(data=data.frame(1), aes(x="N", y=40, label="No"), 
          size=3.75, colour="black", inherit.aes=FALSE, 
          parse=FALSE,y=37) +

# X-Axis Labels: Level 2
geom_text(data=data.frame(1), 
          aes(x=1.5, y=40, label=c("CG", 
                          "CY", 
                          "CR")), 
          size=4.5, colour="black", inherit.aes=FALSE, 
          parse=FALSE,y=30) +

# X-Axis Settings
theme(panel.grid.major.x = element_line(colour=NA)) +
theme(axis.title.x = element_blank()) +
theme(axis.text.x = element_blank()) +
theme(axis.ticks.x = element_blank()) +

# Y-Axis Settings
scale_y_continuous(limits = c(40,100), 
                      breaks=seq(40,100,by=10), 
                      oob = squish) +
theme(axis.title.y = element_blank()) +
theme(axis.text.y = element_text(colour="black")) +
theme(axis.ticks.y = element_line(colour="black")) +
theme(axis.ticks.length = unit(0.25, "cm")) +
theme(panel.grid.major.y = element_line(colour="gray")) +
theme(panel.grid.minor.y = element_line(colour=NA)) +

# General Formatting
theme(plot.margin = unit(c(0,0.25,2,0.25), "lines")) +
theme(panel.margin=unit(0,"cm")) +
theme(panel.background = element_blank()) +
theme(strip.background = element_blank()) +
theme(strip.text = element_blank()) +
theme(legend.position="none") +
scale_fill_manual(values=c("gray90", "gray52")) +
```r
# Lines: X-Axis Level 1
annotation_custom(grob = linesGrob(),
  xmin = 1.5, xmax = 1.5, ymin = 34, ymax = 40)+

# Lines: X-Axis Level 2
annotation_custom(grob = linesGrob(),
  xmin = 0.4, xmax = 0.4, ymin = 28, ymax = 40)+
  annotation_custom(grob = linesGrob(),
  xmin = 2.6, xmax = 2.6, ymin = 28, ymax = 40)+

# Lines: Y-Axis Border
annotation_custom(grob = linesGrob(),
  xmin = 0.4, xmax = 2.6, ymin = 40, ymax = 40)+
  annotation_custom(grob = linesGrob(),
  xmin = 0.4, xmax = 2.6, ymin = 100, ymax = 100)

##### Save Plot
gt <- ggplot_gtable(ggplot_build(Plot))
gt$layout$clip[gt$layout$name=="panel"] <- "off"
png(file = "Excel/Plots/Scenarios_WI-5SC.png",height=350,width=475)
grid.draw(gt)
dev.off()

###########################
#### Plot: All Scenarios: Separated by State and Signal Display
#### Scenarios_WI-5SS.png (475 x 350)
####

##### Create Vector for Variables
test <- vector(length=10)

# Variables to Analyze
#test[1] <- "Scenario"
test[2] <- "Arrangement"
test[3] <- "LT.Indication"
test[4] <- "TH.Indication"
test[5] <- "Traffic"
#test[6] <- "Gender"
#test[7] <- "Age"
#test[8] <- "Experience"
test[9] <- "State"
test[10] <- "Type"

##### Convert Data to Counts and Proportions
source("FYA_CtPrConvert.R")

##### Combine Data into Table for Plot
Tbl1 <- a.pr.correct
Tbl1 <- Tbl1[
```
Tbl$Response=="Correct" &
Tbl$Type=="E" &
Tbl$Arrangement=="5SS" &          # Switch between 3SV, 5SC, 5SS
Tbl$State=="WI",]
# Switch between WI, MA
Tbl <- droplevels(Tbl)

##### Re-Order Factors for Plot
Tbl$TH.Indication <- factor(Tbl$TH.Indication,levels =
c("G","Y","R"))

##### Create Plot
Plot <-
# Input Data
ggplot(Tbl, aes(x=Traffic, y=Proportion*100, fill=LT.Indication, ymin=lower*100, ymax=upper*100)) +
geom_bar(stat = "identity", position="dodge", width=0.80, colour="black") +
facet_grid(.~TH.Indication) +
geom_errorbar(width=0.25, size=0.75, position=position_dodge(width=0.80)) +
geom_text(aes(label=format(round(Proportion*100,digits=1), nsmall=1), y=42.5, fontface="bold"), size=3.5, position=position_dodge(width=0.80)) +

# X-Axis Labels: Level 1
geom_text(data=data.frame(1), aes(x="Y", y=40, label="Yes"), size=3.75, colour="black", inherit.aes=FALSE, parse=FALSE,y=37) +
geom_text(data=data.frame(1), aes(x="N", y=40, label="No"), size=3.75, colour="black", inherit.aes=FALSE, parse=FALSE,y=37) +

# X-Axis Labels: Level 2
geom_text(data=data.frame(1),
aes(x=1.5, y=40, label=c("CG", "CY", "CR")),
size=4.5, colour="black", inherit.aes=FALSE, parse=FALSE,y=30) +

# X-Axis Settings
theme(panel.grid.major.x = element_line(colour=NA)) +
theme(axis.title.x = element_blank()) +
theme(axis.text.x = element_blank()) +
theme(axis.ticks.x = element_blank()) +

# Y-Axis Settings
scale_y_continuous(limits = c(40,100),
breaks=seq(40,100,by=10),
oob = squish) +
theme(axis.title.y = element_blank()) +
theme(axis.text.y = element_text(colour="black")) +
theme(axis.ticks.y = element_line(colour="black")) +
theme(axis.ticks.length = unit(0.25, "cm")) +
theme(panel.grid.major.y = element_line(colour="gray")) +
theme(panel.grid.minor.y = element_line(colour=NA)) +

# General Formatting
theme(plot.margin = unit(c(0,0.25,2,0.25), "lines")) +
theme(panel.margin=unit(0,"cm")) +
theme(panel.background = element_blank()) +
theme(strip.background = element_blank()) +
theme(strip.text = element_blank()) +
theme(legend.position="none") +
scale_fill_manual(values=c("gray90", "gray52")) +

# Lines: X-Axis Level 1
annotation_custom(grob = linesGrob(),
  xmin = 1.5, xmax = 1.5, ymin = 34, ymax = 40)+

# Lines: X-Axis Level 2
annotation_custom(grob = linesGrob(),
  xmin = 0.4, xmax = 0.4, ymin = 28, ymax = 40)+
annotation_custom(grob = linesGrob(),
  xmin = 2.6, xmax = 2.6, ymin = 28, ymax = 40)+

# Lines: Y-Axis Border
annotation_custom(grob = linesGrob(),
  xmin = 0.4, xmax = 2.6, ymin = 40, ymax = 40)+
annotation_custom(grob = linesGrob(),
  xmin = 0.4, xmax = 2.6, ymin = 100, ymax = 100)

#### Save Plot
gt <- ggplot_gtable(ggplot_build(Plot))
gt$layout$clip[gt$layout$name=="panel"] <- "off"
png(file = "Excel/Plots/Scenarios_WI-5SS.png",height=350,width=475)
grid.draw(gt)
dev.off()

##################################################################
##   Plot: All Scenarios: Seperated by State and Signal Display
##   Scenarios_MA-3SV.png (475 x 350)
##################################################################

# Create Vector for Variables
test <- vector(length=10)
#test[1] <- "Scenario"
#test[2] <- "Arrangement"
#test[3] <- "LT.Indication"
#test[4] <- "TH.Indication"
test[5] <- "Traffic"
#test[6] <- "Gender"
#test[7] <- "Age"
#test[8] <- "Experience"
test[9] <- "Experience"
test[10] <- "Type"

##### Convert Data to Counts and Proportions
source("FYA_CtPrConvert.R")

##### Combine Data into Table for Plot
Tbl <- a.pr.correct
Tbl <- Tbl[
    Tbl$Response=="Correct" &
    Tbl$Type=="E" &
    Tbl$Arrangement=="3SV" &      # Switch between 3SV, 5SC, 5SS
    Tbl$State=="MA",]
    # Switch between WI, MA
Tbl <- droplevels(Tbl)

##### Re-Order Factors for Plot
Tbl$TH.Indication <- factor(Tbl$TH.Indication, levels =
c("G","Y","R"))

##### Create Plot
Plot <-
    # Input Data
ggplot(Tbl, aes(x=Traffic, y=Proportion*100, fill=LT.Indication,
ymin=lower*100, ymax=upper*100)) +
geom_bar(stat = "identity", position="dodge",
    width=0.80, colour="black") +
facet_grid(.~TH.Indication) +
geom_errorbar(width=0.25,
    size=0.75, position=position_dodge(width=0.80)) +
geom_text(aes(label=format(round(Proportion*100,digits=1),
        nsmall=1),
    y=42.5, fontface="bold"), size=3.5,
    position=position_dodge(width=0.80)) +

    # X-Axis Labels: Level 1
geom_text(data=data.frame(1), aes(x="Y", y=40, label="Yes"),
    size=3.75, colour="black", inherit.aes=FALSE,
    parse=FALSE,y=37) +
geom_text(data=data.frame(1), aes(x="N", y=40, label="No"),
    size=3.75, colour="black", inherit.aes=FALSE,
    parse=FALSE,y=37) +

    # X-Axis Labels: Level 2
geom_text(data=data.frame(1),
    aes(x=1.5, y=40, label=c("CG",
    "CY",
    "CR")),
    size=4.5, colour="black", inherit.aes=FALSE,
    parse=FALSE,y=30) +
# X-Axis Settings
theme(panel.grid.major.x = element_line(colour=NA)) +
theme(axis.title.x = element_blank()) +
theme(axis.text.x = element_blank()) +
theme(axis.ticks.x = element_blank()) +

# Y-Axis Settings
scale_y_continuous(limits = c(40,100),
    breaks=seq(40,100,by=10),
    oob = squish) +
theme(axis.title.y = element_blank()) +
theme(axis.text.y = element_text(colour="black")) +
theme(axis.ticks.y = element_line(colour="black")) +
theme(axis.ticks.length = unit(0.25, "cm")) +
theme(panel.grid.major.y = element_line(colour="gray")) +
theme(panel.grid.minor.y = element_line(colour=NA)) +

# General Formatting
theme(plot.margin = unit(c(0,0.25,2,0.25), "lines")) +
theme(panel.margin=unit(0,"cm")) +
theme(panel.background = element_blank()) +
theme(strip.background = element_blank()) +
theme(strip.text = element_blank()) +
theme(legend.position="none") +
scale_fill_manual(values=c("gray90","gray52")) +

# Lines: X-Axis Level 1
annotation_custom(grob = linesGrob(),
    xmin = 1.5, xmax = 1.5, ymin = 34, ymax = 40)+

# Lines: X-Axis Level 2
annotation_custom(grob = linesGrob(),
    xmin = 0.4, xmax = 0.4, ymin = 28, ymax = 40)+
annotation_custom(grob = linesGrob(),
    xmin = 2.6, xmax = 2.6, ymin = 28, ymax = 40)+

# Lines: Y-Axis Border
annotation_custom(grob = linesGrob(),
    xmin = 0.4, xmax = 2.6, ymin = 40, ymax = 40)+
annotation_custom(grob = linesGrob(),
    xmin = 0.4, xmax = 2.6, ymin = 100, ymax = 100)+

#### Save Plot
gt <- ggplot_gtable(ggplot_build(Plot))
gt$layout$clip[gt$layout$name=="panel"] <- "off"
png(file = "Excel/Plots/Scenarios_MA-3SV.png",height=350,width=475)
grid.draw(gt)
dev.off()
```r
## Scenarios_MA-5SC.png (475 x 350)

### Create Vector for Variables
```
```n
```r
test <- vector(length=10)
```
```n
### Variables to Analyze
```n
```r
#test[1] <- "Scenario"
#test[2] <- "Arrangement"
test[3] <- "LT.Indication"
test[4] <- "TH.Indication"
test[5] <- "Traffic"
#test[6] <- "Gender"
#test[7] <- "Age"
#test[8] <- "Experience"
test[9] <- "State"
test[10] <- "Type"
```
```n
### Convert Data to Counts and Proportions
```
```n
```r
source("FYA_CtPrConvert.R")
```
```n
### Combine Data into Table for Plot
```
```n
```r
Tbl <- a.pr.correct
Tbl <- Tbl[Tbl$Response=="Correct" &
            Tbl$Type=="E" &
            Tbl$Arrangement=="5SC" &
            Tbl$State=="MA",] # Switch between 3SV, 5SC, 5SS
            # Switch between WI, MA
```
```n
### Re-Order Factors for Plot
```
```n
```r
Tbl$TH.Indication <- factor(Tbl$TH.Indication,levels = c("G","Y","R"))
```
```n
### Create Plot
```
```n
```r
Plot <-
```
```n
```r
# Input Data
ggplot(Tbl, aes(x=Traffic, y=Proportion*100, fill=LT.Indication,
            ymin=lower*100, ymax=upper*100)) +
    geom_bar(stat = "identity", position="dodge",
            width=0.80, colour="black") +
    facet_grid(.~TH.Indication) +
    geom_errorbar(width=0.25,
                  size=0.75, position=position_dodge(width=0.80)) +
    geom_text(aes(label=format(round(Proportion*100,digits=1),
                     nsmall=1),
                y=42.5, fontface="bold"), size=3.5,
                position=position_dodge(width=0.80)) +
    # X-Axis Labels: Level 1
    geom_text(data=data.frame(1), aes(x="Y", y=40, label="Yes"),
              size=3.75, colour="black", inherit.aes=FALSE,
              parse=FALSE,y=37) +
```
```n
```r
geom_text(data=data.frame(1), aes(x="N", y=40, label="No"),
    size=3.75, colour="black", inherit.aes=FALSE,
    parse=FALSE,y=37) +

# X-Axis Labels: Level 2
geom_text(data=data.frame(1),
    aes(x=1.5, y=40, label=c("CG", "CY", "CR")),
    size=4.5, colour="black", inherit.aes=FALSE,
    parse=FALSE,y=30) +

# X-Axis Settings
theme(panel.grid.major.x = element_line(colour=NA)) +
theme(axis.title.x = element_blank()) +
theme(axis.text.x = element_blank()) +
theme(axis.ticks.x = element_blank()) +

# Y-Axis Settings
scale_y_continuous(limits = c(40,100),
    breaks=seq(40,100,by=10),
    oob = squish) +
theme(axis.title.y = element_blank()) +
theme(axis.text.y = element_text(colour="black")) +
theme(axis.ticks.y = element_line(colour="black")) +
theme(axis.ticks.length = unit(0.25, "cm")) +
theme(panel.grid.major.y = element_line(colour="gray")) +
theme(panel.grid.minor.y = element_line(colour=NA)) +

# General Formatting
theme(plot.margin = unit(c(0,0.25,2,0.25), "lines")) +
theme(panel.margin=unit(0,"cm")) +
theme(panel.background = element_blank()) +
theme(strip.background = element_blank()) +
theme(strip.text = element_blank()) +
theme(legend.position="none") +
scale_fill_manual(values=c("gray90", "gray52")) +

# Lines: X-Axis Level 1
annotation_custom(grob = linesGrob(),
    xmin = 1.5, xmax = 1.5, ymin = 34, ymax = 40)+

# Lines: X-Axis Level 2
annotation_custom(grob = linesGrob(),
    xmin = 0.4, xmax = 0.4, ymin = 28, ymax = 40)+
annotation_custom(grob = linesGrob(),
    xmin = 2.6, xmax = 2.6, ymin = 28, ymax = 40)+

# Lines: Y-Axis Border
annotation_custom(grob = linesGrob(),
    xmin = 0.4, xmax = 2.6, ymin = 40, ymax = 40)+
annotation_custom(grob = linesGrob(),
    xmin = 0.4, xmax = 2.6, ymin = 100, ymax = 100)
```
```r
#### Save Plot
gt <- ggplot_gtable(ggplot_build(Plot))
gt$layout$clip[gt$layout$name=="panel"] <- "off"
png(file = "Excel/Plots/Scenarios_MA-5SS.png",height=350,width=475)
grid.draw(gt)
devo.off()

###############################################
##### Create Vector for Variables
test <- vector(length=10)

##### Variables to Analyze
#test[1] <- "Scenario"
test[2] <- "Arrangement"
test[3] <- "LT.Indication"
test[4] <- "TH.Indication"
test[5] <- "Traffic"
#test[6] <- "Gender"
#test[7] <- "Age"
#test[8] <- "Experience"
test[9] <- "State"
test[10] <- "Type"

##### Convert Data to Counts and Proportions
source("FYA_CtPrConvert.R")

##### Combine Data into Table for Plot
Tbl <- a.pr.correct
Tbl <- Tbl[Tbl$Response=="Correct" &
            Tbl$Type=="E" &
            Tbl$Arrangement=="5SS" &
            Tbl$State=="MA",]
            # Switch between 3SV, 5SC, 5SS
            # Switch between WI, MA
Tbl <- droplevels(Tbl)

##### Re-Order Factors for Plot
Tbl$TH.Indication <- factor(Tbl$TH.Indication,levels =
                            c("G","Y","R"))

##### Create Plot
Plot <-
  # Input Data
  ggplot(Tbl, aes(x=Traffic, y=Proportion*100, fill=LT.Indication,
                 ymin=lower*100, ymax=upper*100)) +
  geom_bar(stat = "identity", position="dodge",
```
width=0.80, colour="black") + facet_grid(.~TH.Indication) + geom_errorbar(width=0.25, 
size=0.75, position=position_dodge(width=0.80)) + geom_text(aes(label=format(round(Proportion*100, digits=1), 
nsmall=1), 
y=42.5, fontface="bold"), size=3.5, 
position=position_dodge(width=0.80)) +

# X-Axis Labels: Level 1
geom_text(data=data.frame(1), aes(x="Y", y=40, label="Yes"), 
size=3.75, colour="black", inherit.aes=FALSE, 
parse=FALSE, y=37) + geom_text(data=data.frame(1), aes(x="N", y=40, label="No"), 
size=3.75, colour="black", inherit.aes=FALSE, 
parse=FALSE, y=37) +

# X-Axis Labels: Level 2
geom_text(data=data.frame(1), 
aes(x=1.5, y=40, label=c("CG", 
"CY", 
"CR")), 
size=4.5, colour="black", inherit.aes=FALSE, 
parse=FALSE, y=30) +

# X-Axis Settings
theme(panel.grid.major.x = element_line(colour=NA)) + theme(axis.title.x = element_blank()) + theme(axis.text.x = element_blank()) + theme(axis.ticks.x = element_blank()) +

# Y-Axis Settings
scale_y_continuous(limits = c(40,100), 
breaks=seq(40,100,by=10), 
oob = squish) + theme(axis.title.y = element_blank()) + theme(axis.text.y = element_text(colour="black")) + theme(axis.ticks.y = element_line(colour="black")) + theme(axis.ticks.length = unit(0.25, "cm")) + theme(panel.grid.major.y = element_line(colour="gray")) + theme(panel.grid.minor.y = element_line(colour=NA)) +

# General Formatting
theme(plot.margin = unit(c(0,0.25,2,0.25), "lines")) + theme(panel.margin=unit(0,"cm")) + theme(panel.background = element_blank()) + theme(strip.background = element_blank()) + theme(strip.text = element_blank()) + theme(legend.position="none") + scale_fill_manual(values=c("gray90", "gray52")) +

# Lines: X-Axis Level 1
annotation_custom(grob = linesGrob(), 
xmin = 1.5, xmax = 1.5, ymin = 34, ymax = 40)+
# Lines: X-Axis Level 2
annotation_custom(grob = linesGrob(),
                      xmin = 0.4, xmax = 0.4, ymin = 28, ymax = 40)+
annotation_custom(grob = linesGrob(),
                      xmin = 2.6, xmax = 2.6, ymin = 28, ymax = 40)+

# Lines: Y-Axis Border
annotation_custom(grob = linesGrob(),
                      xmin = 0.4, xmax = 2.6, ymin = 40, ymax = 40)+
annotation_custom(grob = linesGrob(),
                      xmin = 0.4, xmax = 2.6, ymin = 100, ymax = 100)

##### Save Plot
gt <- ggplot_gtable(ggplot_build(Plot))
gt$layout$clip[gt$layout$name=="panel"] <- "off"
png(file = "Excel/Plots/Scenarios_MA-5SS.png", height=350, width=475)
grid.draw(gt)
dev.off()
6.4.4. FYA_Analysis.R

## FYA Analysis
## Dan Reichl & Mark Banghart 11/11/2013
##
### Input Data
###

#### Set working directory to where the files are stored
saved.dir <- getwd()
wd <- "C:/Users/Daniel/Dropbox/Thesis/Data Analysis"
system(wd)

#### Input the Data
source("FYA_InputData.R")

#### Save Plots
#source("FYA_Plots.R")

### Create Table to Display Responses for All Scenarios
###

#### Create Vector for Variables
test <- vector(length=10)

#### Variables to Analyze
#test[1] <- "Scenario"
#test[2] <- "Arrangement"
#test[3] <- "LT.Indication"
#test[4] <- "TH.Indication"
#test[5] <- "Traffic"
#test[6] <- "Gender"
#test[7] <- "Age"
#test[8] <- "Experience"
#test[9] <- "State"
#test[10] <- "Type"

#### Convert Data to Counts and Proportions
source("FYA_CtPrConvert.R")

#### Combine Data into Table
Tbl <- cbind(df.stop, df.yield[,2], df.go[,2], df.idk[,2])
colnames(Tbl)[2:5] <- c("Stop", "Yield", "Go", "IDK")

#################################################################
##   Chi Square Test: Wisc Data vs Mass Data
# 294
# 522
#################################################################

#### Create Vector for Variables
 test <- vector(length=10)

#### Variables to Analyze
# test[1] <- "Scenario"
# test[2] <- "Arrangement"
# test[3] <- "LT.Indication"
# test[4] <- "TH.Indication"
# test[5] <- "Traffic"
# test[6] <- "Gender"
# test[7] <- "Age"
# test[8] <- "Experience"
# test[9] <- "State"
# test[10] <- "Type"

#### Convert Data to Counts and Proportions
source("FYA_CtPrConvert.R")

#### Create Initial Table
 Tbl <- cbind(df.correct, df.fail["Num"])
colnames(Tbl)[(ncol(Tbl)-1):ncol(Tbl)] <- c("Correct", "Fail")

#### Reduce Table into 2 x 2 Contingency Table
 Tbl.2 <- Tbl[Tbl$Type=="E" ,]

#### Run Chi Square Test
 Tbl.Test <- Tbl.2[,c("Correct","Fail")]
 chisq.test(Tbl.Test, correct=FALSE)

#################################################################
##   Chi Square Test: FYA Middle vs FYA Bottom
# 522
# 294
#################################################################

#### Create Vector for Variables
 test <- vector(length=10)

#### Variables to Analyze
# test[1] <- "Scenario"
#test[2] <- "Arrangement"
test[3] <- "LT.Indication"
#test[4] <- "TH.Indication"
#test[5] <- "Traffic"
#test[6] <- "Gender"
#test[7] <- "Age"
#test[8] <- "Experience"
test[9] <- "State"
test[10] <- "Type"

##### Convert Data to Counts and Proportions
source("FYA_CtPrConvert.R")

##### Create Initial Table
Tbl <- cbind(df.correct, df.fail["Num"])
colnames(Tbl)[(ncol(Tbl)-1):ncol(Tbl)] <- c("Correct", "Fail")

##### Run Chi Square Test: Wisconsin Data
Tbl.2 <- Tbl[Tbl$Type=="E" & Tbl$State=="WI",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Massachusetts Data
Tbl.2 <- Tbl[Tbl$Type=="E" & Tbl$State=="MA",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

###############################################################
##################################################################
##   Chi Square Test: FYA Middle vs FYA Bottom: Signal Display
###############################################################

##### Create Vector for Variables
test <- vector(length=10)

##### Variables to Analyze
#test[1] <- "Scenario"
test[2] <- "Arrangement"
test[3] <- "LT.Indication"
#test[4] <- "TH.Indication"
#test[5] <- "Traffic"
#test[6] <- "Gender"
#test[7] <- "Age"
#test[8] <- "Experience"
test[9] <- "State"
test[10] <- "Type"

##### Convert Data to Counts and Proportions
source("FYA_CtPrConvert.R")

##### Create Initial Table
Tbl <- cbind(df.correct, df.fail["Num"])
colnames(Tbl)[(ncol(Tbl)-1):ncol(Tbl)] <- c("Correct", "Fail")

##### Run Chi Square Test: Wisc Data - Three Section Vertical
Tbl.2 <- Tbl[Tbl$Type=="E" &
             Tbl$State=="WI" &
             Tbl$Arrangement=="3SV",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Wisc Data - Five Section Clustered
Tbl.2 <- Tbl[Tbl$Type=="E" &
             Tbl$State=="WI" &
             Tbl$Arrangement=="5SC",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Wisc Data - Five Section Simultaneous
Tbl.2 <- Tbl[Tbl$Type=="E" &
             Tbl$State=="WI" &
             Tbl$Arrangement=="5SS",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Mass Data - Three Section Vertical
Tbl.2 <- Tbl[Tbl$Type=="E" &
             Tbl$State=="MA" &
             Tbl$Arrangement=="3SV",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Mass Data - Five Section Clustered
Tbl.2 <- Tbl[Tbl$Type=="E" &
             Tbl$State=="MA" &
             Tbl$Arrangement=="5SC",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Mass Data - Five Section Simultaneous
Tbl.2 <- Tbl[Tbl$Type=="E" &
             Tbl$State=="MA" &
             Tbl$Arrangement=="5SS",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##################################################################
##   Chi Square Test: Signal Display Comparisons
##################################################################
### Create Vector for Variables

```r
test <- vector(length=10)
```

#### Variables to Analyze

```r
#test[1]  <- "Scenario"
#test[2]  <- "Arrangement"
#test[3]  <- "LT.Indication"
#test[4]  <- "TH.Indication"
#test[5]  <- "Traffic"
#test[6]  <- "Gender"
#test[7]  <- "Age"
#test[8]  <- "Experience"
#test[9]  <- "State"
#test[10] <- "Type"
```

#### Convert Data to Counts and Proportions

```r
source("FYA_CtPrConvert.R")
```

#### Create Initial Table

```r
Tbl <- cbind(df.correct, df.fail["Num"])
colnames(Tbl)[(ncol(Tbl)-1):ncol(Tbl)] <- c("Correct", "Fail")
```

#### Run Chi Square Test: Wisc Data:

- **Three Section Vertical - Five Section Clustered**
  ```r
  Tbl.2 <- Tbl[Tbl$Type=="E" & Tbl$State=="WI" &
               (Tbl$Arrangement=="3SV" | Tbl$Arrangement=="5SC"),]
  Tbl.Test <- Tbl.2[,c("Correct","Fail")]
  chisq.test(Tbl.Test, correct=FALSE)
  ```

- **Three Section Vertical - Five Section Simultaneous**
  ```r
  Tbl.2 <- Tbl[Tbl$Type=="E" & Tbl$State=="WI" &
               (Tbl$Arrangement=="3SV" | Tbl$Arrangement=="5SS"),]
  Tbl.Test <- Tbl.2[,c("Correct","Fail")]
  chisq.test(Tbl.Test, correct=FALSE)
  ```

- **Five Section Clustered - Five Section Simultaneous**
  ```r
  Tbl.2 <- Tbl[Tbl$Type=="E" & Tbl$State=="WI" &
               (Tbl$Arrangement=="5Sc" | Tbl$Arrangement=="5SS"),]
  Tbl.Test <- Tbl.2[,c("Correct","Fail")]
  chisq.test(Tbl.Test, correct=FALSE)
  ```

- **Four Section Vertical - Three Section Vertical**
  ```r
  Tbl.2 <- Tbl[(Tbl$Type=="E" | Tbl$Type=="B") &
              Tbl$State=="WI" &
              (Tbl$Arrangement=="4SV" | Tbl$Arrangement=="3SV"),]
  Tbl.Test <- Tbl.2[,c("Correct","Fail")]
  ```
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Wisc Data:
##### Four Section Vertical - Five Section Clustered
Tbl.2 <- Tbl[(Tbl$Type=='E' | Tbl$Type=='B') &
             Tbl$State=='WI' &
             (Tbl$Arrangement=='4SV' | Tbl$Arrangement=='5Sc'),]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Wisc Data:
##### Four Section Vertical - Five Section Simultaneous
Tbl.2 <- Tbl[(Tbl$Type=='E' | Tbl$Type=='B') &
             Tbl$State=='WI' &
             (Tbl$Arrangement=='4SV' | Tbl$Arrangement=='5SS'),]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Wisc Data:
##### Three Section Vertical - Five Section Clustered
Tbl.2 <- Tbl[Tbl$Type=='E' &
             Tbl$State=='MA' &
             (Tbl$Arrangement=='3SV' | Tbl$Arrangement=='5Sc'),]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Wisc Data:
##### Three Section Vertical - Five Section Simultaneous
Tbl.2 <- Tbl[Tbl$Type=='E' &
             Tbl$State=='MA' &
             (Tbl$Arrangement=='3SV' | Tbl$Arrangement=='5SS'),]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Mass Data:
##### Five Section Clustered - Five Section Simultaneous
Tbl.2 <- Tbl[(Tbl$Type=='E' | Tbl$Type=='B') &
             Tbl$State=='MA' &
             (Tbl$Arrangement=='4SV' | Tbl$Arrangement=='3SV'),]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Mass Data:
##### Four Section Vertical - Five Section Clustered
Tbl.2 <- Tbl[(Tbl$Type=='E' | Tbl$Type=='B') &
             Tbl$State=='MA' &
             (Tbl$Arrangement=='4SV' | Tbl$Arrangement=='5Sc'),]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)
(Tbl$Arrangement=="4SV" | Tbl$Arrangement=="5SC"),]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Mass Data: 
##### Four Section Vertical - Five Section Simultaneous 
Tbl.2 <- Tbl[(Tbl$Type=="E" | Tbl$Type=="B") & 
    Tbl$State=="MA" & 
    (Tbl$Arrangement=="4SV" | Tbl$Arrangement=="5SS"),]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##################################################################
##   Chi Square Test: Thru Indication Comparisons 
##################################################################

##### Create Vector for Variables 
test <- vector(length=10)

##### Variables to Analyze 
#test[1]  <- "Scenario" 
#test[2]  <- "Arrangement" 
#test[3]  <- "LT.Indication" 
test[4]  <- "TH.Indication" 
#test[5]  <- "Traffic" 
#test[6]  <- "Gender" 
#test[7]  <- "Age" 
#test[8]  <- "Experience" 
test[9]  <- "State" 
test[10] <- "Type"

##### Convert Data to Counts and Proportions  
source("FYA_CtPrConvert.R")

##### Create Initial Table  
Tbl <- cbind(df.correct, df.fail["Num"]) 
colnames(Tbl)[(ncol(Tbl)-1):ncol(Tbl)] <- c("Correct", "Fail")

##### Run Chi Square Test: Wisc Data: Green - Yellow 
Tbl.2 <- Tbl[(Tbl$Type=="E" & 
    Tbl$State=="WI" & 
    (Tbl$TH.Indication=="G" | Tbl$TH.Indication=="Y" ),]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Wisc Data: Green - Red 
Tbl.2 <- Tbl[(Tbl$Type=="E" & 
    Tbl$State=="WI" & 
    (Tbl$TH.Indication=="G" | Tbl$TH.Indication=="R" ),]

Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Wisc Data: Yellow - Red
Tbl.2 <- Tbl[Tbl$Type=="E" &
   Tbl$State=="WI" &
   (Tbl$TH.Indication=="Y" | Tbl$TH.Indication=="R" ),]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Mass Data: Green - Yellow
Tbl.2 <- Tbl[Tbl$Type=="E" &
   Tbl$State=="MA" &
   (Tbl$TH.Indication=="G" | Tbl$TH.Indication=="Y" ),]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Mass Data: Green - Red
Tbl.2 <- Tbl[Tbl$Type=="E" &
   Tbl$State=="MA" &
   (Tbl$TH.Indication=="G" | Tbl$TH.Indication=="R" ),]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Mass Data: Yellow - Red
Tbl.2 <- Tbl[Tbl$Type=="E" &
   Tbl$State=="MA" &
   (Tbl$TH.Indication=="Y" | Tbl$TH.Indication=="R" ),]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

########################################################################
########################################################################
##   Chi Square Test: Traffic Comparisons
########################################################################
########################################################################

##### Create Vector for Variables
test <- vector(length=10)

##### Variables to Analyze
#test[1] <- "Scenario"
#test[2] <- "Arrangement"
#test[3] <- "LT.Indication"
#test[4] <- "TH.Indication"
#test[5] <- "Traffic"
#test[6] <- "Gender"
#test[7] <- "Age"
#test[8] <- "Experience"
#test[9] <- "State"
#test[10] <- "Type"
### Convert Data to Counts and Proportions

source("FYA_CtPrConvert.R")

### Create Initial Table

Tbl <- cbind(df.correct, df.fail["Num"])

colnames(Tbl)[(ncol(Tbl)-1):ncol(Tbl)] <- c("Correct", "Fail")

### Run Chi Square Test: Wisc Data

Tbl.2 <- Tbl[Tbl$Type=="E" & Tbl$State=="WI",]

Tbl.Test <- Tbl.2[,c("Correct","Fail")]

chisq.test(Tbl.Test, correct=FALSE)

### Run Chi Square Test: Mass Data

Tbl.2 <- Tbl[Tbl$Type=="E" & Tbl$State=="MA",]

Tbl.Test <- Tbl.2[,c("Correct","Fail")]

chisq.test(Tbl.Test, correct=FALSE)

### Chi Square Test: Gender Comparisons

### Create Vector for Variables

test <- vector(length=10)

### Variables to Analyze

#test[1] <- "Scenario"
#test[2] <- "Arrangement"
#test[3] <- "LT.Indication"
#test[4] <- "TH.Indication"
#test[5] <- "Traffic"
#test[6] <- "Gender"
#test[7] <- "Age"
#test[8] <- "Experience"
#test[9] <- "State"
#test[10] <- "Type"

### Convert Data to Counts and Proportions

source("FYA_CtPrConvert.R")

### Create Initial Table

Tbl <- cbind(df.correct, df.fail["Num"])

colnames(Tbl)[(ncol(Tbl)-1):ncol(Tbl)] <- c("Correct", "Fail")

### Run Chi Square Test: Wisc Data

Tbl.2 <- Tbl[Tbl$Type=="E" &
Tbl$State=='WI',]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Mass Data
Tbl.2 <- Tbl[Tbl$Type=='E' &
            Tbl$State=='MA',]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##################################################################
###################################
###############################
##   Chi Square Test: Driving Experience Comparisons
##   #
#  ### Create Vector for Variables
#test <- vector(length=10)

##### Variables to Analyze
#test[1] <- "Scenario"
#test[2] <= "Arrangement"
#test[3] <= "LT.Indication"
#test[4] <= "TH.Indication"
#test[5] <= "Traffic"
#test[6] <= "Gender"
#test[7] <= "Age"
test[8] <= "Experience"
test[9] <= "State"
test[10] <= "Type"

##### Convert Data to Counts and Proportions
source("FYA_CtPrConvert.R")

##### Create Initial Table
Tbl <- cbind(df.correct, df.fail["Num"])
colnames(Tbl)[(ncol(Tbl)-1):ncol(Tbl)] <= c("Correct", "Fail")

##### Run Chi Square Test: Wisc Data: <5 vs 5-10
Tbl.2 <= Tbl[Tbl$Type=='E' &
            (Tbl$Experience=='<5' | Tbl$Experience=='5-10') &
            Tbl$State=='WI',]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Wisc Data: <5 vs >10
Tbl.2 <= Tbl[Tbl$Type=='E' &
            (Tbl$Experience=='<5' | Tbl$Experience=='>10') &
            Tbl$State=='WI',]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)
##### Run Chi Square Test: Wisc Data: 5-10 vs >10
Tbl.2 <- Tbl[Tbl$Type=="E" &
  (Tbl$Experience=="5-10" | Tbl$Experience==">10") &
  Tbl$State=="WI",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Mass Data: <5 vs 5-10
Tbl.2 <- Tbl[Tbl$Type=="E" &
  (Tbl$Experience=="<5" | Tbl$Experience=="5-10") &
  Tbl$State=="MA",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Mass Data: <5 vs >10
Tbl.2 <- Tbl[Tbl$Type=="E" &
  (Tbl$Experience=="<5" | Tbl$Experience==">10") &
  Tbl$State=="MA",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Mass Data: 5-10 vs >10
Tbl.2 <- Tbl[Tbl$Type=="E" &
  (Tbl$Experience=="5-10" | Tbl$Experience==">10") &
  Tbl$State=="MA",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

#########################################################################
#########################################################################
##   Chi Square Test: Age Comparisons
##
#########################################################################
#########################################################################

##### Create Vector for Variables
test <- vector(length=10)
#test[1] <- "Scenario"
#test[2] <- "Arrangement"
#test[3] <- "LT.Indication"
#test[4] <- "TH.Indication"
#test[5] <- "Traffic"
#test[6] <- "Gender"
#test[7] <- "Age"
#test[8] <- "Experience"
#test[9] <- "State"
#test[10] <- "Type"

##### Convert Data to Counts and Proportions
source("FYA_CtPrConvert.R")
##### Create Initial Table
Tbl <- cbind(df.correct, df.fail['Num'])
colnames(Tbl)[(ncol(Tbl)-1):ncol(Tbl)] <- c("Correct", "Fail")

##### Run Chi Square Test: Wisc Data: 18-24 vs 25-44
Tbl.2 <- Tbl[Tbl$Type=='E' &
           (Tbl$Age=="18-24" | Tbl$Age=="25-44") &
           Tbl$State=="WI",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Wisc Data: 18-24 vs 45-64
Tbl.2 <- Tbl[Tbl$Type=='E' &
           (Tbl$Age=="18-24" | Tbl$Age=="45-64") &
           Tbl$State=="WI",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Wisc Data: 18-24 vs 65+
Tbl.2 <- Tbl[Tbl$Type=='E' &
           (Tbl$Age=="18-24" | Tbl$Age=="65+") &
           Tbl$State=="WI",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Wisc Data: 25-44 vs 45-64
Tbl.2 <- Tbl[Tbl$Type=='E' &
           (Tbl$Age=="25-44" | Tbl$Age=="45-64") &
           Tbl$State=="WI",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Wisc Data: 25-44 vs 65+
Tbl.2 <- Tbl[Tbl$Type=='E' &
           (Tbl$Age=="25-44" | Tbl$Age=="65+") &
           Tbl$State=="WI",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Wisc Data: 45-64 vs 65+
Tbl.2 <- Tbl[Tbl$Type=='E' &
           (Tbl$Age=="55-64" | Tbl$Age=="65+") &
           Tbl$State=="WI",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Mass Data: 18-24 vs 25-44
Tbl.2 <- Tbl[Tbl$Type=='E' &
           (Tbl$Age=="18-24" | Tbl$Age=="25-44") &
           Tbl$State=="MA",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)
##### Run Chi Square Test: Mass Data: 18-24 vs 45-64
Tbl.2 <- Tbl[Tbl$Type=="E" &
  (Tbl$Age=="18-24" | Tbl$Age=="45-64") &
  Tbl$State=="MA",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Mass Data: 18-24 vs 65+
Tbl.2 <- Tbl[Tbl$Type=="E" &
  (Tbl$Age=="18-24" | Tbl$Age=="65+") &
  Tbl$State=="MA",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Mass Data: 25-44 vs 45-64
Tbl.2 <- Tbl[Tbl$Type=="E" &
  (Tbl$Age=="25-44" | Tbl$Age=="45-64") &
  Tbl$State=="MA",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Mass Data: 25-44 vs 65+
Tbl.2 <- Tbl[Tbl$Type=="E" &
  (Tbl$Age=="25-44" | Tbl$Age=="65+") &
  Tbl$State=="MA",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)

##### Run Chi Square Test: Mass Data: 45-64 vs 65+
Tbl.2 <- Tbl[Tbl$Type=="E" &
  (Tbl$Age=="55-64" | Tbl$Age=="65+") &
  Tbl$State=="MA",]
Tbl.Test <- Tbl.2[,c("Correct","Fail")]
chisq.test(Tbl.Test, correct=FALSE)
7. REFERENCES


