BICYCLIST UNDERSTANDING, USE, AND PREFERENCE OF VARIOUS INNOVATIVE BICYCLE INFRASTRUCTURE TREATMENTS

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To Leslee, my encouragement, my love, and my bride…

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LIST OF ABBREVIATIONS

AASHTO	America Association of State Highway and Transportation Officials
BMUFL	Bicycles May Use Full Lane
BPL	Bicycle Priority Lane
FHWA	Federal Highway Administration
ITE	Institute of Transportation Engineers
MUTCD	Manual on Uniform Traffic Control Devices
NCUTLO	National Committee on Uniform Traffic Laws and Ordinances
NHTSA	National Highway Traffic Safety Administration
UVC	Uniform Vehicle Code

SUMMARY

As bicycle transportation has increased, especially among commuters, so have the types of bicycle infrastructure facilities increased. This report focuses on the application of several of these innovative bicycle infrastructure treatments in three different scenarios: shared-lane facilities, bicycle-specific facilities, and high-conflict area treatments. The focus treatments include the sharrow, Sharrow Bicycle Priority Lane, Green Bicycle Priority Lane, Bicycles May Use Full Lane sign, green bike lane, bike-box, green lane in a conflict area, and elephant's footprint markings. The goal of this report is to gather how well bicyclists understand their meaning, how they would use each, and which treatments are most preferred among bicyclists.

Data for this study was gathered in the form of an online survey administered to 1000 bicyclists of varying levels and purposes from different regions of the country. The survey gathers general rider characteristics, asks how each bicyclist would use each treatment in different traffic speed and volume scenarios, and finally each respondent rates each of the treatments in order of preference. Using the survey results, the effectiveness of each treatment is analyzed in detail by different population segments of those surveyed. Bicyclist riding characteristics and route choice factors are also examined in detail to better understand the sampled population of riders. The results are discussed and conclusions to the effectiveness of each treatment are made.

CHAPTER 1: INTRODUCTION

1.1 The Growth of Bicycling in the United States

Bicycles have been a viable mode of transportation in the United States since before the turn of the 20th century, even before the automobile. Their ease of use in addition to affordability when compared to automobiles has made travel by bicycle a competitive alternative for specific types of trips. Bicycling has grown in popularity as a recreational activity over the last 40 years, and due to many factors its popularity is growing rapidly in the 21st century.

In early 2011, the price of a regular gallon of gasoline in the United States rose rapidly to over $4.00 per gallon. National trends data has shown that these rising fuel costs have caused more price-sensitive drivers to seek other modes of transportation, including transit, walking, and, for many, bicycling. Additionally, congestion in urban areas is an ever-growing problem as many metropolitan areas are still experiencing rapid suburban growth resulting in increased trip lengths. The ability to save time spent in traffic on less stressful and sometimes even quicker bicycle commutes is appealing to many.

The "green" movement in the United States has also been a factor in expanded bicycle transportation. Many users are willing to try bicycling as a way to reduce air pollution and their own carbon footprints. Finally, as obesity is becoming a more of a problem in America, some people are willing to find new ways to stay healthy. Many states, municipalities, and even private companies are also providing incentive programs to promote healthy lifestyles that including bicycling and walking.

Each of these factors is a major reason for the increased use of bicycles over the past decade. For example, the number of adults commuting to work by bike has increased 44% from 2000 to 2009 [1]. However, another reason for this increase could be attributed to states and cities redirecting transportation funds that for the past century have gone towards highway expansion. Now, improving bicycle infrastructure is receiving more emphasis among agency budgets. In a study conducted by the United States Conference of Mayors in 2011, 75% of the 176 city mayors across America surveyed said they would support an increase of the federal gas tax if a greater share of the funding were invested in bicycle and pedestrian infrastructure. Only 49% said they would support an increase if a greater share of funds went towards highway infrastructure [2].

The goal in these bicycle facilities is not just increased ridership, but also improved safety. From 2000 to 2009 there were more than 411,000 fatalities on roadways in the United States, and 7053 of these involved a bicyclist. During this period the percentage of fatalities involving a bicycle remained quite steady between 1.4 and 1.9% of all fatalities [3]. As the Federal Highway Administration (FHWA) moves "Towards Zero Deaths", bicycle fatalities are included in this effort as well.

More cities are installing bicycle lanes, in addition to experimenting with new bicycle facility treatments with the goal of increased ridership and safety. Two of these new treatments were adopted in the 2009 Manual on Uniform Traffic Control (MUTCD) the “sharrow” and “bicycles may use full lane” sign [4]. Other cities are experimenting with treatments such as the “bike-box”, “bicycle priority lane”, green bicycle lanes, bicycle boulevards, colored conflict areas, improved signage, and expanded bicycle-only facilities.

Various studies have been done on several of these new “innovative” treatments. The majority of these studies’ efforts only pertained to one specific treatment in a particular city or area and its effects within that area. Most studies analyzed if the treatments increased use by bicyclists and safety. A few as well did attempt to interact with the bicyclists themselves to gather information on how well they understood the treatment as well as their reaction to its effectiveness.

The purpose of this thesis is to contribute to our knowledge of bicycle strategies and lane treatment by researching multiple treatments simultaneously. Innovative bicycle treatments are examined with the goal of understanding how well bicyclists understand their purpose, to what extent they would use them, and which treatments they would prefer over others. This was done through a bicyclist-oriented internet survey. The contents of this survey are discussed in a later section.

1.2 Organization of the Thesis

The following chapter discusses the bicycle treatments that were the focus of this study, divided into the functional classes of their use. The next chapter presents relevant literature, including past studies on the treatments, documents that contain pertinent design regulations and guidelines, and other studies regarding bicycle ridership, demand, and safety. Chapter 4 includes details on the design of the survey administered to bicyclists. The results of the survey are first presented and discussed in Chapter 5. Chapter 6 interprets the survey results, and Chapter 7 presents the conclusions from this study.

CHAPTER 2: STUDIED BICYCLE TREATMENTS

2.1 Study Treatments

The study treatments are divided into three functional classes, based on the roadway area of their use: 1) bicycle-specific facilities, 2) shared-lane facilities, and 3) high-conflict area facilities. Bicycle-specific facilities are areas that are intended for the sole use of bicycles, such as bike lanes. They are not meant to be occupied by vehicles or pedestrians.

Shared facilities are often seen in areas where bicycle-specific facilities cannot be used because of either limited space and/or funds. The Uniform Vehicle Code, or UVC, labels such lanes as “substandard width lanes,” which are “too narrow for a bicycle and a vehicle to travel safely side by side within the same lane” [5]. There is no specific width in feet that is the threshold of such a lane, but it is instead left up to the judgment of the roadway engineer. They most often include areas of roadway that are shared by both vehicles and bicycles, either by design or necessity. They could include any standard vehicle roadway, as bicycles must ride on the roadway because of the lack of alternatives. Finally, the last class of treatments is facilities used in high-conflict areas. A “high-conflict area” is an area where a vehicle facility and/or lane crosses or merges with a bicycle-specific facility. This most often happens at intersections, or where bicycle lanes cross on- or off-ramps or turn lanes.

It should be noted that many of these facilities are often accompanied by signage to help assist motorist awareness and understanding. However, for the scope of this study, these combined sign and marking treatments are not considered, as only the understanding of the bicyclists themselves is the focus of this study. Isolating each treatment from any accompanying signage assists in being able to determine direct effects of each treatment, independent of signage effects.

2.2 Bicycle-Specific Facilities

2.2.1 "Traditional" Bicycle Lane

The traditional bike lane (seen in Figure 1) is included in this study in order to form a basis for comparison with other bike-specific lanes. This bicycle lane has been in use for a long time and nearly all roadway users are familiar with what it looks like, as well as its meaning and purpose. Standard bike lanes are a minimum of 4' wide, and include lane markings to help users delineate it from a vehicle lane or parking area. Guidelines for its development have been included in The American Association of State Highway and Transportation Officials' (AASHTO) *Bike Book* [6] and markings and signage are also mentioned in the MUTCD Section 9 [4].

Figure 1: Traditional Bicycle Lane

2.2.2 Green Bicycle Lane

A green bicycle lane follows the same purpose and guidelines of a traditional bicycle lane, but is painted green (see Figure 2 and Figure 3). The green paint is intended to make motorists more aware of bicycles that may be occupying the lanes. This effect also can help boost bicyclists' confidence to ride safely in the lane and still be seen by motorists. Such lanes have been implemented in many cities over the past decade, including New York, NY, San Francisco, CA, Seattle, WA, and Portland, OR. For this study the green bicycle lane will be studied both with and without traditional bicycle lane markings on the roadway.

Figure 2: Green Bicycle Lane with Accompanying Lane Markings

Figure 3: Green Bicycle Lane without Lane Markings

2.3 Shared-Lane Facilities:

2.3.1 "Share the Road" sign

A "Share the Road" sign (see Figure 4) is a common treatment on a roadway without any bicycle-specific rights-of-way such as bike lanes, yet still experiences high bicycle volumes. It is directed at motorists to increase awareness of bicycles in the roadway and "share" the lane with bicycles when encountered [4]. This means that motorists should yield to bicycles that may be slowing them down or blocking their path; motorists should only pass a bicycle when it is safe. Many states in recent years have passed variations of "safe passing laws" to ensure motorists give more space between them and the bicyclists when passing. It is expected that the effect of these signs on motorists will give bicyclists more confidence to ride on shared rights-of-way.

Figure 4: “Share the Road” sign (image from MUTCD [4])

2.3.2 “Bicycles May Use Full Lane” sign

The “Bicycles May Use Full Lane” (see Figure 5) sign is a new addition to the MUTCD Chapter 9 [4]. The MUTCD states that this sign should be used in a “substandard width lane” where travel lanes are too narrow for bicyclists and motor vehicles to operate side by side. Its purpose is to inform road users that bicyclists might occupy the travel lane. It can also give bicyclists more confidence to use the roadway as they may feel that motorists will be more aware of the presence of bicycles.

Figure 5: “Bicycles May Use Full Lane” sign (BMUFL) (image from MUTCD [4])

2.3.3 *Sharrows*

A “sharrow” is derived from the phrase “shared-lane arrow” and can be seen in Figure 6. The MUTCD refers to it as a “shared lane marking” [4]. It can be used by itself or in tandem with the “Bicycles May Use Full Lane” sign. It is placed to the right side of the traffic lane where curbside parking is present, but at least 11 feet from the curb (or edge of pavement) and is spaced out evenly along a roadway at intervals less than 250 feet. It was adopted in the most recent (2009) edition of the MUTCD. It can serve many purposes, including helping bicyclists ride in the correct position on the street out of the “dooring-zone” of parked vehicles, making motorists more aware of bicycles in the traveled lane, giving bicyclists more confidence to ride in the roadway, reducing the occurrence of bicycles riding on the sidewalk, and reducing wrong-way bicycling.

Figure 6: Sharrow Pavement Marking

2.3.4 Bicycle Priority Lane (Sharrows)

The sharrow bicycle priority lane seen in Figure 7 has seen use in Brookline, MA [7]. Its initial use was along a much traveled route by bicycles that had continuous bicycle lanes except for a few blocks where this was implemented. It is similar to the sharrow, but also includes the dotted lines on either side to give both cyclists and motorists more of a perceived bicycle lane. It is not a true bicycle lane, however, in that it is still in shared space with automobiles. It serves similar purposes as the sharrows: helping position cyclists safely, alerting motorists of bicycles, giving bicyclists more perceived safety, reducing sidewalk riding, and reducing wrong-way riding.

Figure 7: Sharrow Bicycle Priority Lane

2.3.5 Green Bicycle Priority Lane

The green bicycle priority lane, seen in Figure 8, has the same purpose as the sharrow bicycle priority lane seen in Brookline, MA, except that it is painted continuously green rather than the use of intermittent dotted lines [7]. It has been experimented with in Salt Lake City, UT and Long Beach, CA. The green bicycle priority lane may be placed more to the center of the traffic lane than the sharrow.

Figure 8: Green Bicycle Priority Lane

2.4 Conflict Area Facilities

2.4.1 Bike Box

The bike-box treatment, seen in Figure 9, was first applied in the United States in 1998 in Eugene, OR [8] as a way to reduce bicycle-vehicle conflicts at signal controlled intersections. It is often colored green, but is not necessarily green in all instances. The bike-box is a box in front of the vehicle stop bar where bicyclists should stop on a red signal indication. The pre-existing vehicle stop bar is often moved back when the box is applied to allow ample room for bicycles without stopping in the pedestrian crosswalk (when present). The bike box is most often accompanied by the prohibition of right turns on red. Its purpose is to reduce vehicle-bicycle conflicts by allowing bicycles to skip vehicle queues and wait in front of any vehicles within a more direct line of sight. It can help avoid the traditional “right-hook” where a right turning vehicle clips a bicycle moving straight through the intersection in a right-side adjacent bicycle lane. It has been applied in Eugene, OR, Portland, OR [13], Austin, TX [14], San Francisco, CA, and Decatur, GA among other cities.

Figure 9: Bike Box at Intersection (photo courtesy of *itdp* via flickr.com)

2.4.2 Colored Lanes

This treatment involves coloring a portion of a bicycle lane green in high-conflict bicycle and motor vehicle areas, as seen in Figure 10 [9]. This is done to improve motorist expectancy and visibility of bicycles within bike lanes as vehicles cross over the lane. These situations are often seen where turn bays begin before an intersection, where bicycle lanes cross in front of highway on-ramps and off-ramps, or through high-conflict intersections. Blue paint experiments were tried in Portland, OR, but these have since been changed to green to be consistent with the green bike boxes. Austin, TX, Seattle, WA, New York, NY and Chicago, IL in addition to other cities have all experimented with green bicycle lanes in high-conflict areas.

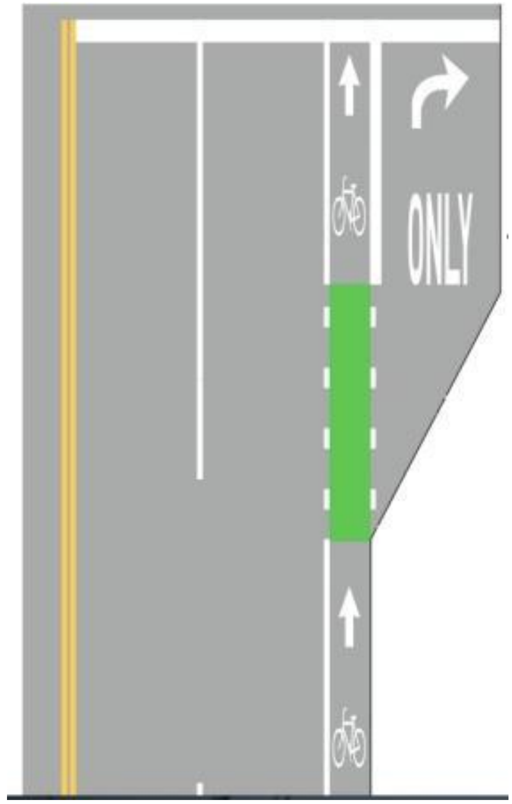


Figure 10: Colored Bicycle Lane in High-Conflict Area (background image from MUTCD)

2.4.3 *"Elephant Footprint" Markings*

The markings seen in Figure 11 are known as "Elephant Footprint markings" or "Elephant's feet", as they are large 15-20" square markings similar to the size of an elephant's footprint [10]. They are used in the same high-conflict area applications as the colored lanes mentioned previously. The markings originated in Europe and have been used in the United Kingdom, the Netherlands, and Hungary. They have more recently been applied in Vancouver and Toronto, Canada, but there are no known applications yet in the United States.

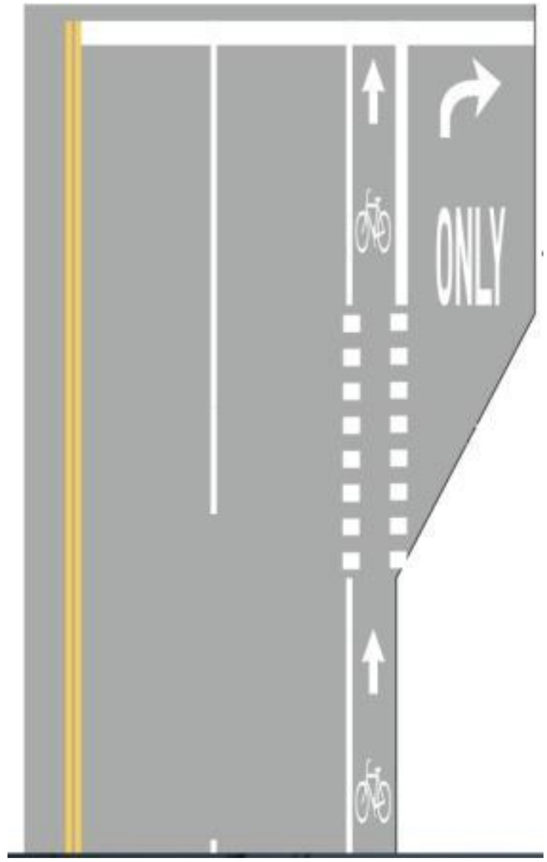


Figure 11: “Elephant Footprint” Markings through Bicycle Lane Conflict Area
(background image from MUTCD)

CHAPTER 3: RELEVANT LITERATURE

3.1 Technical Guides

AASHTO's *Guide for the Development of Bicycle Facilities*, or the "Bike Book" as it is better known, was designed to provide information on the design of bicycle facilities [6]. Its purpose is to enhance and encourage safe bicycle travel by providing information to accommodate bicycle traffic in most riding environments. It does not provide strict standards, but rather a collection of guidelines from bicycle design officials. It provides information with regard to the planning and design of bicycle facilities for shared roadways, bike lanes, shared used paths, and other various environments. The *Bike Book*, however, has not been edited or updated since 1999 and is thus missing more than a decade of advancements in bicycle facility research and development. It does not include sharrows, bicycle priority lanes, bike boxes, nor colored lanes or segments of lanes in any way.

Chapter 9 of the MUTCD, or Manual on Uniform Traffic Control Devices, is devoted to traffic control for bicycle facilities [4]. It includes all approved signage as well as pavement markings and colors. In the 2009 edition, sharrows and the "Bicycles May Use Full Lane" sign were both included for the first time. Outside of the "Share the Road" sign, all of the other focus treatments of this study are not included within the MUTCD. The MUTCD also includes codes in section 3 regarding the color, shape, and size of various pavement markings. To date, the green pavement marking often used with the treatments in this study is not mentioned.

The Institute of Transportation Engineers (ITE) released an informational report in 2002 entitled "Innovative Bicycle Treatments" [10]. The text examines various new techniques used both in North America and Europe as ways of improving bicycle safety. It provides basic information on each treatment, its uses (if any), and any accompanying studies (if any) regarding each treatment. It is a good resource to quickly visualize and understand many atypical bicycle treatments that have been recently implemented or considered.

ITE's Transportation Planning Handbook also includes an extensive chapter on Pedestrian and Bicycle Planning [11]. It includes a thorough discussion of proper planning involved in the implementation of context-appropriate bicycle facilities. The needs for bicycle facilities along shared roadways, dedicated facilities, bicycle storage and parking, off-road and multi-use trails, and avoidance of hazards and all discussed.

3.2 Treatment Evaluation Studies

In the last five years there have been many new studies on the implementation of sharrows in specific locations. In 2010, Hunter et al. released a study evaluating a segment of roadway in which sharrows were applied in Cambridge, MA [12]. The study was a before-and-after evaluation of how bicyclists and motorists both behaved along a roadway segment where sharrows were placed next to parallel parking 10 feet from the curb. It was part of a study for the FHWA intended to examine alternatives to the 11 feet from curb sharrow placement as recommended in the MUTCD. Results showed that after implementation of the sharrows, motorists on average gave an additional 14 inches of space between themselves and parked cars when no bicycles were present. This would tend to increase operating space for bicycles when they are present. Results also showed a statistically significant decrease in bicyclists altering their direction to allow vehicles to pass, a decrease in open vehicle doors when bicycles are present, an increase in safe passing by vehicles, and an increase in motorists who yielded to bicyclists' rights-of-way.

In addition to sharrows, Furth et al. did a study on other bicycle priority treatments in various cities [7]. The authors describe the negotiation that occurs between bicyclists and motor vehicles in shared lanes as to the positioning and behavior of each. Some bicyclists are more confident to ride in the center of the lane, while others actively yield their right-of-way to faster motorists and ride to the far right, often next to parked vehicles. Additionally, while some motorists are willing to yield to the speed and location of lane-taking bicyclists, many do not seem to respect the right of the bicyclists and may aggressively overtake them. The behavior of both bicyclists and motorists were examined with the application of green bicycle priority lanes in Salt Lake City, UT and Long Beach, CA and with the application of the bicycle priority lane with sharrows in Brookline, MA. Before-and-after studies of each did show that the priority lane treatments had some success in shifting bicyclists' position farther away from parked cars and off of riding on the sidewalks, but did not completely eliminate such behavior.

Brady et al. did a study of three separate focus treatments in Austin, TX in 2010: sharrows, the "Bicycles May Use Full Lane" (BMUFL) sign, and green colored bicycle lanes in high-conflict areas [9]. The sharrows were placed along five different corridors along with the BMUFL sign. Results showed that while sidewalk riding was not reduced, motorists did often provide more space to bicycles and passed less often. The green lanes were installed at two different conflict area sections of bicycle lane that were previously dashed-line bicycle lane sections. The results saw motorists were more likely to yield to bicyclists and use turn signals when crossing through the green sections.

The bike-box is a treatment that has gathered much attention quickly in the last decade, and several reports exist on its implementation in various settings. The initial report by Hunter in 2000 examined the bike box's first use within the United States in Eugene, OR [8] and found that only 22% of bicyclists that could have used the box did in fact utilize it and noted little change in conflicts from the before to the after period. Monsere et al. did a similar before-and-after study of ten bike-boxes implemented in Portland in 2010 [13]. Their study also focused on any effects between an unpainted and green painted box. Motorists were found to have a high rate of compliance and understanding of the markings, with 73% stopping behind the box. The number of conflicts with bicycles decreased while ridership increased overall. Improvements were found over traditional intersections, but no conclusions were made about the effect of the green color. Loskorn et al. also did a study of bike-box implementation in 2010 in Austin, TX [14]. They performed a 3 step before-and-after study that examined effects before the box was applied, once its outline was applied, and after the green (or chartreuse) color was applied. Bicyclists exhibited more predicable behavior with the implementation of the bike box, including 20-26% stopping in the box. The addition of the green color saw significant improvements in bicyclist behavior, yet demonstrated that motorists did not comprehend its meaning very well.

3.3 Behavioral Studies

A report written by Van Houten et al. in 2004 studied how pavement markings affect the lateral position of bicyclists and motorists in addition to the preference of bicyclists [15]. Components of bicycle lane markings were added sequentially and the corresponding responses of bicyclists and motorists were measured. All three treatments significantly increased the percentage of bicyclists riding more than 9' and 10' from the curb. User surveys also showed that a full bike lane was the most preferred treatment though there was no change in comfort levels from the control to full bicycle lane treatment. Surveys also showed that the presence of a bicycle lane also made motorists more aware of bicyclists in the roadway.

Dill et al. performed a 2006 study to examine the factors that affect bicycling demand in Portland, OR [16]. Results were analyzed from a random phone survey of adults in the region. They found that proximity to off-street trails and bike lanes was not associated with higher levels of riding. However, the availability of bicycle lanes was associated with more bicycling and the desire to ride a bicycle more among adults in the study.

Jacobsen performed a study in 2003 to determine if there is relationship between the number of bicyclists and pedestrians, and the rate of collisions involving each [17]. Across several data sets, results consistently showed that the likelihood of a pedestrian or bicyclist being struck by a motor vehicle varies inversely with the amount of walking and bicycling. Jacobsen suggests that it is unlikely pedestrians and bicyclists are more cautious as their numbers increase, thus the result is attributed to safer behaviors exhibited by motorists. This demonstrates the "safety in numbers" belief that the presence of more bicyclists (and pedestrians) in the roadways increases motorists' awareness resulting in increased safety.

CHAPTER 4: SURVEY DESIGN

4.1 Data Collection Strategy

In order to measure how well users understand the innovative new treatments, a survey was designed and administered to bicyclists in several metropolitan areas. The collection of field data and curbside interviews of bicyclists using these treatments was not feasible, as many of these techniques are spread throughout the country (or even further) with no city having all of them present. Also due to the nature of the study, a before-and-after data collection approach is also unfeasible.

Data collection relied on a user survey. A primary purpose of the survey was to understand how well bicyclists would understand the treatments when encountered while riding a bicycle. Additionally, the survey was designed so that the relationship between various traffic conditions and where bicyclists would ride on the roadway could also be determined. Finally, the last purpose of the survey was to determine which of the treatments users would prefer most.

4.2 Survey Design

A copy of the survey is found in Appendix A. The survey was divided into five functional sections. The first section was on basic user information. This included:

- Gender
- Age

- Home residence area density (urban, suburban, etc.)
- Home zip code
- Primary purpose for riding

These questions allowed for the results to be analyzed among age groups, gender, types of riders, and the density/geography of the area in which they ride.

The second section of the survey gathered additional rider characteristics based on riding purpose (commuting, recreational/leisure, or shopping/social). Respondents were asked how often they ride for a specific purpose and how far they ride (commuters only). They were then asked how they select their bicycling route by rating the following choices:

- Shortest distance
- Lowest vehicle traffic
- Availability of bike lanes/facilities
- Terrain/least number of hills
- Attractions/Points of Interest
- Best workout (recreational riders only)

The respondents were then asked again how they select their route, but this time were told to assume bike lanes/facilities were available along all possible routes (and the "availability of bike lanes/facilities" choice was removed). Finally, they were asked to rate their riding prowess from the following definitions:

- Strong and Fearless: will ride regardless of facilities (lanes); trip distance is not such an issue
- Enthused and Confident: comfortable in traffic with appropriate facilities (lanes, etc.); prefer shorter trip distances
- Interested but Concerned: not comfortable in traffic; will ride in low traffic volume, low-speed conditions (more residential streets, paths) [18]

The third section of the survey then introduced each treatment individually through an image. No definition of the treatment was given so that the reaction to each could be measured as if users were encountering each on a roadway for the first time. Participants were shown a picture of a treatment, and then asked for that situation where on the roadway they would ride their bicycle (i.e. “in the bicycle lane”, “as far to the right as possible”, “on the sidewalk”, etc.). This question was asked four times, for four different combinations of vehicle traffic and speed limit:

- Vehicle traffic is LIGHT to MODERATE and the speed limit is 25 MPH.
- Vehicle traffic is MODERATE to HEAVY and the speed limit is 25 MPH.
- Vehicle traffic is LIGHT TO MODERATE and the speed limit is 45 MPH.
- Vehicle traffic is MODERATE to HEAVY and the speed limit is 45 MPH.

This was done for the following treatments, including a standard city street with curbside parking and no bicycle treatment as a basis for comparison:

- Standard city street, curbside parking, no bicycle treatment

- Green bicycle lane, without white in-lane markings, curbside parking
- Green bicycle lane, with white in-lane markings, curbside parking
- Sharrows, with curbside parking (placed at the MUTCD minimum 11' from curb)
- Sharrow bicycle priority lane, with curbside parking
- Green bicycle priority lane, with curbside parking
- "Share the Road" sign on standard city street, curbside parking
- "Bicycles May Use Full Lane" sign on standard city street, curbside parking

Since the bike-box is a place intended for bicyclists to stop rather than ride, a separate image and set of questions was used for it. An image of a bike box was shown with it divided into 5 different sections for respondents to choose from in which they would stop for two different scenarios:

- The bicycle lane continues on the other side of the intersection
- The bicycle lane does *not* continue on the other side of the intersection

With the introduction of each treatment, users were asked if they have ever seen or encountered it previously. They could choose between having encountered it while on a bicycle, in a vehicle, both, and neither.

Once it was determined how well users understood each treatment and how they would utilize each, they were provided with a brief definition of each treatment. This included the purpose of the treatment, its potential benefits, and where bicyclists are to ride on the roadway when each is marked. Respondents were also allowed to comment on each treatment if they felt compelled to do so. This section also included the definitions for the high-conflict area treatments: green colored lane sections and the "elephant's footprints" markings.

The fifth and final section then asked bicyclists to rate each treatment from most preferred to least preferred. This was done after the definition of each was introduced so that respondents could make more informed decisions on preference. The treatments were divided again into their three classes for comparison, and the answer order was randomized among each survey. The treatments rated were:

- Bicycle-specific facilities:
    - Traditional bicycle lane
    - Green bicycle lane (without white in-lane markings)
    - Green bicycle lane (with white in-lane markings)
- Shared lane facilities:
    - "Share the Road" sign
    - "Bicycles May Use Full Lane" sign
    - Sharrows
    - Sharrow bicycle priority lane
    - Green bicycle priority lane

- Conflict-area treatments
    - Standard dashed bicycle lane lines
    - Elephant's footprint markings
    - Green lane in conflict area

The images shown with each treatment were an important aspect of the survey design. Efforts were made to ensure that each treatment was shown in the same scenario to eliminate any bias between image differences related to traffic, streetscape, roadway design, parked cars, etc. For example, respondents may prefer one treatment because its image could show what appears to be a slower roadway in a nicer area over another treatment shown on a busier roadway with a less appealing streetscape. Rather than show actual images of each treatment in different environments, one handpicked image was used for each class of treatments; then each treatment was visually overlaid using a computer program to ensure each was shown in a comparable scenario and environment. The chosen images were both on two-lane two-way urban streets with curbside parking, except that one contained a traditional bicycle lane while the other did not.

4.3 Survey Dissemination

Handouts were made encouraging bicyclists to take the survey, and were handed to bicyclists on the street, at common bicycling parks and trails, and at local bike shops in the Atlanta area. Additionally, a link to the survey was shared with the email lists and social media pages of many bicycle clubs, shops, and advocacy groups in many cities through the southeast and other metropolitan areas. Sharing the survey with advocacy groups was a great way to gain additional responses, but could also introduce self-selection into the results. For example, the members of advocacy groups are often confident and often pro-bicycle opinionated riders; this is possibly not a true overall population sample of all bicyclists. However, this is partly accounted for by the basic information gained from riders through the first several questions (type of riding, frequency, and skill level) and is addressed in the next chapters.

Within the survey, respondents were asked for their ZIP codes in order to obtain geographic information of the sample population. A map of all of the respondents' locations can be seen in Figure 12.

Table 1 also shows the cities and metropolitan areas with five or more responses from each, as well as their "bicycle friendless" award level as rated in 2011 by the League of American Bicyclists **Error! Reference source not found.**. Cities without an award level were either too small to be rated (Clemson, SC) or were not bicycle-friendly enough to receive an award level (Atlanta, GA and Dallas, TX). From the table it can be seen that there was the highest concentration of responses in the Washington, DC and Atlanta, GA metropolitan areas.

Figure 12: Location of Survey Respondents

Table 1: Location of Survey Respondents, and Community Bicycle Friendliness

Metro Area/City	Number of Responses	Bicycle Friendliness Award Level [19]
Washington, DC	387	Silver
Atlanta, GA	200	--
Champaign, IL	43	Bronze
Chattanooga, TN	35	Bronze
Columbia, SC	33	Bronze
Madison, WI	33	Gold
San Francisco, CA	26	Gold
Milwaukee, WI	21	Bronze
Seattle, WA	16	Gold
Portland, OR	13	Platinum
Chicago, IL	10	Silver
Los Angeles, CA	10	*Bronze
Austin, TX	9	Silver
Baltimore, MD	6	Bronze
Dallas, TX	6	--
Boston, MA	5	Silver
Clemson, SC	5	--
Columbus, OH	5	Bronze
Minneapolis, MN	5	Gold

*Los Angeles is not ranked, but Long Beach which had several responses is Bronze

CHAPTER 5: OVERVIEW OF SURVEY RESULTS

5.1 General Respondent Information

Overall, there were 1000 completed survey responses. It is important to remember that the survey results may not be a true population sample, but can still be valuable for research regarding innovative bicycle lane treatments with only limited previous research. In addition, the survey results state rather than reveal the preferences of the respondents, and stated preferences do not always coincide with revealed preferences.

The survey respondents were 65.1% male, 63.2% under the age of 40, and 65.7% reside in urban areas (both CBD and non-CBD). These results can be seen in Table 2, Table 3, and Table 4.

Table 2: Gender of Survey Respondents

Gender	Male	Female
Frequency	651	349
Percent (%)	65.1	34.9

Table 3: Age Distribution of Survey Respondents

Ages	Frequency	Percent (%)
15-19	9	0.9
20-24	109	10.9
25-29	226	22.6
30-34	180	18.0
35-39	108	10.8
40-44	106	10.6
45-49	82	8.2
50-59	134	13.4
60+	46	4.6

Table 4: Urban/Suburban/Rural Distribution of Survey Respondents

Residence Area	Frequency	Percent (%)
Urban CBD	149	14.9
Urban Non-CBD	508	50.8
Suburban	304	30.4
Rural	39	3.9

5.2 Riding Purpose, Trip Frequency, and Trip Length

Of the survey respondents, 52.0% considered commuting to be their primary purpose, while 38.7% said recreation/leisure is their primary purpose of riding. Of the commuters, 64.4% ride four or more times a week, and 96.3% ride at least once each week. More than half of shopping/social trip riders also said they ride at least four times a week, while the majority of the recreational riders ride just one to three times a week (see Table 5 and Table 6).

Table 5: Trip Purpose of Survey Respondents

Primary Purpose	Frequency	Percent (%)
Commuting	520	52.0
Recreation/Leisure	387	38.7
Shopping/Social	93	9.3

Table 6: Frequency of Bicycle Trips of Survey Respondents, by Trip Purpose

Riding Frequency	4+ Times / Week	1-3 Times / Week	1-3 Times / Month	<1 / Month
Commuters	335 (64.4%)	166 (31.9%)	14 (2.7%)	5 (1.0%)
Shopping/Social	48 (51.6%)	37 (39.8%)	8 (8.6%)	0 (0%)
Recreation/Leisure	95 (24.5%)	194 (50.1%)	59 (15.2%)	39 (10.1%)

Commuting riders were also asked how long their usual one-way commute by bicycle is. The largest group is the 40.0% that ride between two and five miles, and 11.7% of commuters actually ride more than ten miles one-way (see Table 7).

Table 7: One-Way Trip Distances for Bicycle Commuters

Distance	<1 mile	1-2 miles	2-5 miles	5-10 miles	10+ miles	Varies
Frequency	19	99	208	121	61	12
Percentage (%)	3.7	19.0	40.0	23.3	11.7	2.3

5.3 Riding Levels

All bicyclists were asked to define their riding level, based on the three classifications discussed in the survey design. Commuters appear to be the most confident riders, followed by social/shopping trip riders, with recreational riders being the least confident of the three (see Table 8).

Table 8: Self-Defined Bicyclist Riding Levels

Type of Rider	Strong and Fearless	Enthused and Confident	Interested but Concerned
Commuter	291	204	25
Percentage	56.0%	39.2%	4.8%
Shopping/Social	38	46	9
Percentage	40.9%	49.5%	9.7%
Recreation/Leisure	150	130	107
Percentage	38.8%	33.6%	27.6%
OVERALL	479	380	141
Percentage	47.9%	38.0%	14.1%

5.4 Route Choice Factors

Each of the three riding purpose groups was individually asked how they choose their route among a number of factors. The following tables show the weighted average ranking of each criteria, with a score of 1 given to the lowest rated criteria, 2 to second lowest, and so on (out of 5 criteria, a rating of 5.0 would mean *every respondent* rated it as most important). Both commuters and recreational riders rank the amount of vehicle traffic to be the most important, while shopping/social trip riders rank minimum distance to be the most important. Attractions/Points of Interest was the least important of all criteria among all three groups. These results can be seen in Table 9, Table 10, and Table 11.

Table 9: Commuter Bicyclist Ranking of Factors Affecting Route Choice

Commuters' Criteria	Average Rank
Least Vehicle Traffic	3.76
Availability of Bike Lanes/Facilities	3.53
Shortest Distance	3.51
Terrain/Hills	2.66
Attractions/Points of Interest	1.54

Table 10: Shopping Bicyclist Ranking of Factors Affecting Route Choice

Shopping/Social Criteria	Average Rank
Shortest Distance	3.49
Availability of Bike Lanes/Facilities	3.46
Least Vehicle Traffic	3.41
Terrain/Hills	2.77
Attractions/Points of Interest	1.86

Table 11: Recreational Bicyclist Ranking of Factors Affecting Route Choice

Recreational Criteria	Average Rank
Least Vehicle Traffic	4.80
Availability of Bike Lanes/Facilities	3.94
Best Workout	3.84
Attractions/Points of Interest	3.20
Terrain/Hills	3.12
Shortest Distance	2.10

As a supplemental question to bicyclists' route choice preferences, a second question asked respondents to rate how they would choose their route if there were bike facilities available along all possible routes. Though this is not a completely realistic situation in our current state of infrastructure, it was intended merely to determine what effect this would have on bicyclists. Table 12, Table 13, and Table 14 show that with the availability of bicycle facilities, vehicle traffic ratings drop relative to other criteria.

Table 12: Commuter Bicyclist Ranking of Factors Affecting Route Choice with Bike Lane Present

Commuters' Criteria	Average Rank
Shortest Distance	3.23
Least Vehicle Traffic	2.81
Terrain/Hills	2.46
Attractions/Points of Interest	1.51

Table 13: Shopper Bicyclist Ranking of Factors Affecting Route Choice with Bike Lane Present

Shopping/Social Criteria	Average Rank
Shortest Distance	3.11
Terrain/Hills	2.57
Least Vehicle Traffic	2.54
Attractions/Points of Interest	1.78

Table 14: Recreational Bicyclist Ranking of Factors Affecting Route Choice with Bike Lane Present

Recreational Criteria	Average Rank
Least Vehicle Traffic	3.64
Best Workout	3.40
Attractions/Points of Interest	3.01
Terrain/Hills	2.84
Shortest Distance	2.11

5.5 Shared Lane Rider Positioning

The next section of questions asked respondents where they would ride on a roadway, given a picture and one of the four traffic scenarios discussed earlier. Each scenario included on-street parking to keep results consistent. The presence of on-street parking can greatly alter how and where bicyclists ride on a roadway, as the potential for opening car doors is an added danger to that of vehicle traffic. Thus this study addressed results only in these situations with on-street parallel parking.

For each question, respondents had to opportunity to answer “other” and write in an answer as to where they would ride given a picture and traffic scenario. Many utilized this opportunity, especially for the scenarios that asked them to assume traffic speed limit is 45 mph. Several respondents seemed almost offended that a situation of a 2-lane urban arterial with parallel parking could have a speed limit of 45 mph, and they did not answer the question. However, the situation was not meant to be absolutely realistic, but to grasp how sensitive bicyclists are to traffic speed and volume. Each of the write-in answers was read and classified into one of a few categories. These categories did include “no answer” when respondents did not use the comment section to answer the question, but instead to share an opinion. It should also be noted that the MUTCD recommended (but not regulated) use of sharrows is on roadways of speed limits 35-mph and lower [4]. However, it was included in the survey for the sake of consistency between questions and to establish rider sensitivity to traffic in such a situation.

For the scenarios where there is no bicycle-specific lane, a shared-lane treatment was the option shown to respondents. There was also a “control” scenario first showed that was just a “standard” city street with parallel parking and no bicycle treatments. Table 15, Table 16, Table 17, and Table 18 show the results for each of the four traffic scenarios.

Table 15: Bicyclist Positioning on Roadway with Different Treatments, 25-mph, Light Traffic

25 mph, Light-Moderate Traffic

Treatment	**None**	**Sharrow**	**Sharrow BPL**	**Green BPL**	**“Share the Road”**	**“BMUFL” Sign**
Middle of Lane/ Left of Treatment	330 (33.0%)	282 (28.2%)	102 (10.2%)	7 (0.7%*)	253 (25.3%)	391 (39.1%)
Within Treatment	--	668 (66.8%)	846 (84.6%)	905 (90.5%)	--	--
Right, 3-5' from parked cars	596 (59.6%)	--	--	9 (0.9%)	655 (65.5%)	551 (55.1%)
As far right as possible	54 (5.4%)	29 (2.9%)	28 (2.8%)	40 (4.0%)	75 (7.5%)	42 (4.2%)
On the sidewalk	8 (0.8%)	3 (0.3%)	5 (0.5%)	4 (0.4%)	8 (0.8%)	7 (0.7%)
Not sure	9 (0.9%)	9 (0.9%)	11 (1.1%)	21 (2.1%)	5 (0.5%)	5 (0.5%)
**Alternate Route	1 (0.1%)	1 (0.1%)	1 (0.1%)	3 (0.3%)	1 (0.1%)	1 (0.1%)
**Varies	2 (0.2%)	5 (0.5%)	3 (0.3%)	10 (1.0%)	3 (0.3%)	3 (0.3%)
**No Answer	0 (0%)	3 (0.3%)	4 (0.4%)	1 (0.1%)	0 (0%)	0 (0%)

* - “Other” write-in answer was left of green lane treatment

** - “Other” write-in answers

Table 16: Bicyclist Positioning on Roadway with Different Treatments, 25-mph, Moderate-Heavy Traffic

25 mph, Moderate-Heavy Traffic						
Treatment	**None**	**Sharrow**	**Sharrow BPL**	**Green BPL**	**“Share the Road”**	**“BMUFL” Sign**
Middle of Lane/Left of Treatment	283 (28.3%)	241 (24.1%)	91 (9.1%)	10 (1.0%)*	234 (23.4%)	355 (35.5%)
Within Treatment	--	652 (65.2%)	790 (79.0%)	856 (85.6%)	--	--
Right, 3-5' from parked cars	459 (45.9%)	--	--	13 (1.3%)	571 (57.1%)	518 (51.8%)
As far right as possible	141 (14.1%)	58 (5.8%)	66 (6.6%)	70 (7.0%)	134 (13.4%)	83 (8.3%)
On the sidewalk	85 (8.5%)	26 (2.6%)	27 (2.7%)	18 (1.8%)	41 (4.1%)	27 (2.7%)
Not sure	19 (1.9%)	12 (1.2%)	16 (1.6%)	21 (2.1%)	11 (1.1%)	11 (1.1%)
**Alternate Route	9 (0.9%)	5 (0.5%)	5 (0.5%)	5 (0.5%)	6 (0.6%)	3 (0.3%)
**Varies	4 (0.4%)	2 (0.2%)	2 (0.2%)	7 (0.7%)	3 (0.3%)	3 (0.3%)
**No Answer	0 (0%)	4 (0.4%)	3 (0.3%)	0 (0%)	0 (0%)	0 (0%)

* - “Other” write-in answer was left of green lane treatment

** - “Other” write-in answers

Table 17: Bicyclist Positioning on Roadway with Different Treatments, 45-mph, Light-Moderate Traffic

45 mph, Light-Moderate Traffic						
Treatment	**None**	**Sharrow**	**Sharrow BPL**	**Green BPL**	**"Share the Road"**	**"BMUFL" Sign**
Middle of Lane/Left of Treatment	168 (16.8%)	188 (18.8%)	85 (8.5%)	9 (0.9%)*	151 (15.1%)	271 (27.1%)
Within Treatment	--	574 (57.4%)	673 (67.3%)	762 (76.2%)	--	--
Right, 3-5' from parked cars	418 (41.8%)	--	--	13 (1.3%)	483 (48.3%)	465 (46.5%)
As far right as possible	115 (11.5%)	68 (6.8%)	85 (8.5%)	80 (8.0%)	144 (14.4%)	102 (10.2%)
On the sidewalk	205 (20.5%)	88 (8.8%)	78 (7.8%)	57 (5.7%)	137 (13.7%)	90 (9.0%)
Not sure	29 (2.9%)	35 (3.5%)	34 (3.4%)	34 (3.4%)	35 (3.5%)	34 (3.4%
**Alternate Route	45 (4.5%)	33 (3.3%)	31 (3.1%)	29 (2.9%)	39 (3.9%)	30 (3.0%)
**Varies	2 (0.2%)	4 (0.4%)	4 (0.4%)	6 (0.6%)	4 (0.4%)	2 (0.2%)
**No Answer	18 (1.8%)	10 (1.0%)	10 (1.0%)	10 (1.0%)	7 (0.7%)	6 (0.6%)

* - "Other" write-in answer was left of green lane treatment

** - "Other" write-in answers

Table 18: Bicyclist Positioning on Roadway with Different Treatments, 45-mph, Moderate-Heavy Traffic

45 mph, Moderate-Heavy Traffic

Treatment	**None**	**Sharrow**	**Sharrow BPL**	**Green BPL**	**"Share the Road"**	**"BMUFL" Sign**
Middle of Lane/Left of Treatment	129 (12.9%)	151 (15.1%)	80 (8.0%)	9 (0.9%)*	118 (11.8%)	206 (20.6%)
Within Treatment	--	447 (44.7%)	540 (54.0%)	642 (64.2%)	--	--
Right, 3-5' from parked cars	267 (26.7%)	--	--	8 (0.8%)	333 (33.3%)	360 (36.0%)
As far right as possible	111 (11.1%)	76 (7.6%)	93 (9.3%)	101 (10.1%)	147 (14.7%)	117 (11.7%)
On the sidewalk	321 (32.1%)	183 (18.3%)	152 (15.2%)	110 (11.0%)	245 (24.5%)	179 (17.9%)
Not sure	46 (4.6%)	54 (5.4%)	57 (5.7%)	59 (5.9%)	57 (5.7%)	57 (5.7%)
**Alternate Route	102 (10.2%)	69 (6.9%)	57 (5.7%)	48 (4.8%)	83 (8.3%)	66 (6.6%)
**Varies	8 (0.8%)	9 (0.9%)	4 (0.4%)	8 (0.8%)	5 (0.5%)	4 (0.4%)
**No Answer	16 (1.6%)	11 (1.1%)	17 (1.7%)	15 (1.5%)	12 (1.2%)	11 (1.1%)

* - "Other" write-in answer was left of green lane treatment

** - "Other" write-in answers

5.6 Bicycle-Specific Facility Bicyclist Positioning

In addition to questions about shared-lane facilities, there were also questions regarding green bicycle-specific lanes. A pair of treatments was shown, one with the white bike image in the lane and the other without, to help determine what effect this lane marking could have in addition to coloring the lane. The results show minimal difference, but with slightly more riders using the green lane when it is more clearly marked as a bicycle lane (see Table 19, Table 20, Table 21, and Table 22).

Table 19: Bicyclist Positioning on Roadway with Different Color Treatments, 25-mph, Light-Moderate Traffic

25 mph, Light-Moderate Traffic

Rider Position	Middle of Traffic Lane	Right side of traffic lane	Green Lane	On Sidewalk	Not Sure	Alternate Route	Varies	No Answer
Green Lane, no markings	35 (3.5%)	147 (14.7%)	79 (79.0%)	2 (0.2%)	6 (0.6%)	1 (0.1%)	11 (1.1%)	8 (0.8%)
Green Lane, w/ markings	30 (3.0%)	127 (12.7%)	826 (82.6%)	1 (0.1%)	4 (0.4%)	2 (0.2%)	4 (0.4%)	6 (0.6%)

Table 20: Bicyclist Positioning on Roadway with Different Treatments, 25-mph, Moderate-Heavy Traffic

25 mph, Moderate-Heavy Traffic

Rider Position	Middle of Traffic Lane	Right side of traffic lane	Green Lane	On Sidewalk	Not Sure	Alternate Route	Varies	No Answer
Green Lane, no markings	36 (3.6%)	107 (10.7%)	827 (82.7%)	2 (0.2%)	10 (1.0%)	3 (0.3%)	11 (1.1%)	4 (0.4%)
Green Lane, w/ markings	29 (2.9%)	88 (8.8%)	857 (85.7%)	5 (0.5%)	7 (0.7%)	4 (0.4%)	5 (0.5%)	5 (0.5%)

Table 21: Bicyclist Positioning on Roadway with Different Treatments, 45-mph, Light Traffic

45 mph, Light-Moderate Traffic

Rider Position	Middle of Traffic Lane	Right side of traffic lane	Green Lane	On Sidewalk	Not Sure	Alternate Route	Varies	No Answer
Green Lane, no markings	26 (2.6%)	93 (9.3%)	809 (80.9%)	25 (2.5%)	15 (1.5%)	18 (1.8%)	7 (0.7%)	7 (0.7%)
Green Lane, w/ markings	27 (2.7%)	76 (7.6%)	828 (82.8%)	25 (2.5%)	12 (1.2%)	13 (1.3%)	9 (0.9%)	10 (1.0%)

Table 22: Bicyclist Positioning on Roadway with Different Treatments, 45-mph, Moderate-Heavy Traffic

45 mph, Moderate-Heavy Traffic

Rider Position	Middle of Traffic Lane	Right side of traffic lane	Green Lane	On Sidewalk	Not Sure	Alternate Route	Varies	No Answer
Green Lane, no markings	22 (2.2%)	64 (6.4%)	776 (77.6%)	63 (6.3%)	22 (2.2%)	38 (3.8%)	7 (0.7%)	8 (0.8%)
Green Lane, w/ markings	21 (2.1%)	54 (5.4%)	790 (79.0%)	63 (6.3%)	23 (2.3%)	31 (3.1%)	7 (0.7%)	11 (1.1%)

5.7 "Bike-Box" Rider Positioning

The last set of questions was designed to determine how well users understand a "bike-box" treatment and how they would use it. A bike box was shown divided into five different sections, A-E, and users were asked to determine in which section they would stop while on a bicycle (see Figure 13). The first scenario described a situation in which the bicycle lane continues on the other side of the intersection. The second scenario describes the same situation, except that the bicycle lane *does not* continue on the other side of the intersection (see Table 23).

These results are similar to the findings from the literature where bike-box stopping location was studied. Monsere et al. observed 78.9% of bicyclists stopped in sections B, C, and D [13]. Loskorn et al. observed 91.8% stopped in sections B, C, and D at one location and 49.3% at another location [14]. The total percentage in the same sections B, C, and D for the two scenarios in this study were 95.1% and 93.0%.

Figure 13: Bike Box Divided into Five Sections (background image courtesy of *itdp* at flickr.com)

Table 23: Bicyclist Stopping Position at Bike-Box, Given Bike Lane Continuation Scenario

Rider Stopped Position	Section A	Section B	Section C	Section D	Section E
Bike Lane Continues	35 (3.5%)	29 (2.9%)	420 (42.0%)	492 (49.2%)	24 (2.4%)
Bike Lane Ends	41 (4.1%)	33 (3.3%)	585 (58.5%)	312 (31.2%)	29 (2.9%)

5.8 User Preference of Treatments

Finally, after the respondents were introduced to each treatment, its purpose, and its definition they were asked to rate each in order of preference. There were three primary areas in which treatments were ranked: shared-lane facilities, bicycle-specific facilities, and conflict-area treatments (see Table 24, Table 25, and Table 26). The Green Bicycle Priority Lane was the most preferred among shared-lane treatments. The green bicycle lane with accompanying markings was the most preferred among bicycle-specific facilities. Lastly, the green colored lane was the most preferred among high-conflict area treatments.

Table 24: Bicyclist Ranking of Different Shared-Lane Treatments

Shared-Lane Treatments

Treatment	Average Rank
Green BPL	4.25
Sharrow BPL	3.74
Sharrow	3.02
"Bikes May Use Full Lane"	2.51
"Share the Road"	1.48

Table 25: Bicyclist Ranking of Different Bicycle-Specific Treatments

Bicycle-Specific Lanes

Treatment	Average Rank
Green Lane, with markings	2.72
Standard Bike Lane	1.81
Green Lane, no markings	1.47

Table 26: Bicyclist Ranking of Different Conflict Area Treatments

Conflict Area Treatments

Treatment	Average Rank
Green Colored Area	3.43
Elephant Footprints	2.99
Dashed Lines	2.33
None	1.25

CHAPTER 6: DISCUSSION OF FINDINGS

6.1 Riding Level Distribution

The purpose of the section is to delve deeper into the statistical results and interpret their meanings, reasoning, and potential implications for designers and bicyclists alike. Not all results of the survey will be discussed in this section, however, just those with significant findings and those that need greater explanation with supporting statistics.

According to the 2000 census, about half of the United States population lived in suburban areas. This leaves about 30% of the population living in true "urban" areas, with the last 20% still residing in rural areas **Error! Reference source not found.**. This 30-50-20 split can be compared to the 66-30-4 split of the population sample in this survey seen in Table 4. However the majority of bicycle facilities in the United States are in urban areas and thus a sample of urban bicyclists is a better representation of those that could more regularly utilize these facilities.

The first observations from the survey results pertain to the riding level of the surveyed bicyclists. The definitions were similar to those used in a study in Portland, OR that used a phone survey to gather a sample riding level of the entire city population, not just bicyclists. These results show only about 0.5% of people in the city consider themselves "Strong and Fearless", with another 7% considering themselves "Enthused and Confident." The largest proportion from the study was 60% of the population that consider themselves “Interested but Concerned.” The Portland study also included 33% of the population that said they will ride a bicycle “No Way, No How” [18]. This group was not included in this study since the survey was designed only for those who will and do use a bicycle at least sparingly. If you removed this third of the population that will not or do not ride a bicycle, the resulting proportions are 0.7%, 10.4%, and 88.9% for the “Strong and Fearless”, “Enthused and Confident”, and “Interested but Concerned” groups, respectively.

Figure 14 shows that, among the sample of those surveyed, a majority consider themselves “Strong and Fearless” while many more consider themselves “Enthused and Confident.” Only a small proportion of riders consider themselves “Interested but Concerned.” The difference in survey populations between this report and the Portland population survey is again largely due to the groups that the survey was distributed among. This can be interpreted to mean that this survey focuses on the responses of those that use the roadway most. Many of the results will still be broken out based on the “level” of the rider to determine how each will respond in different situations. Regardless, engineers should design a bicycle facility on a roadway not just for the most confident, but to account for the safety of all bicyclists in addition to the safety of pedestrians and vehicles alike.

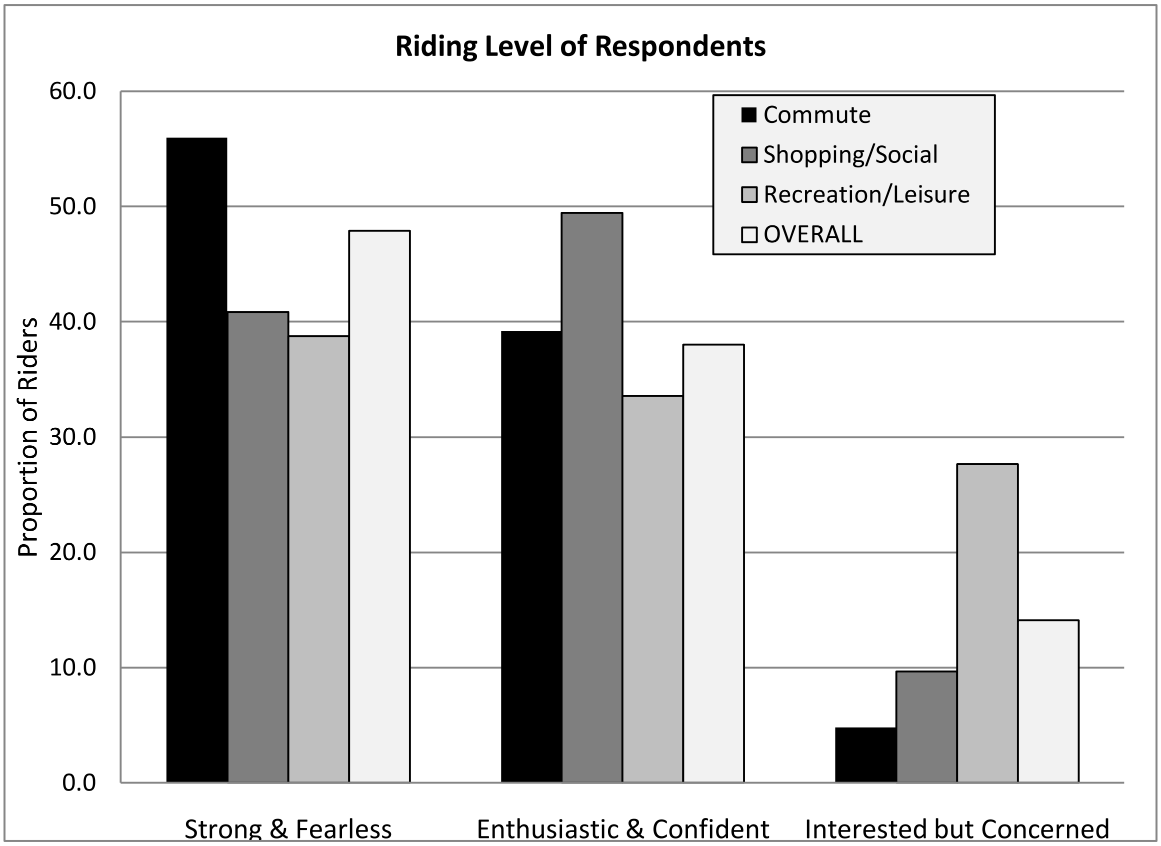


Figure 14: Riding Level of Survey Respondents

6.2 Riders' Purpose

Among the survey respondents, 52.0% cited commuting as their primary purpose of riding. Of the commuters, less than one quarter have an average one-way distance under 2 miles. Nearly two-thirds, 63.3% have a commute between 2 and 10 miles (see Figure 15). Bicycle commuters are not just making short trips, but rather covering significant distances. Additionaly, of the commuters surveyed, 96.3% said they do so at least once a week, and 64.4% said they do at least four times a week. This demonstrates how those commuting are not just covering large distances, but are doing so regularly. Both statistics stress the importance of a well-integrated bicycle network in the areas where there are a significant portion of commuters who do so by bicycle. It should be the goal of planners and engineers to account for these riders, especially in metropolitan areas making great efforts to promote non-automobible modes of travel.

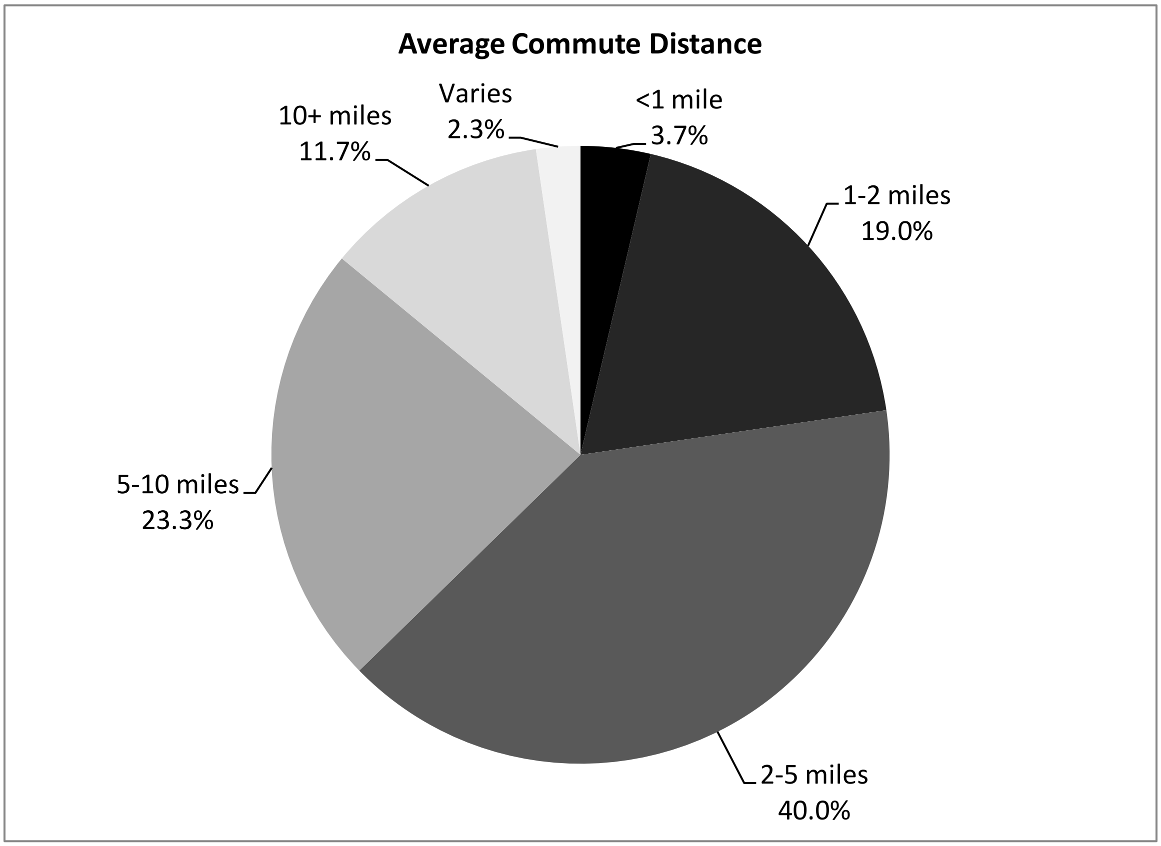


Figure 15: Average One-Way Distance of Bicycle Commuters

6.3 Groups' Route Choice Preferences

Those aspects of route choice considered important by all users, and the results for commuters (shown in Table 9) showed "Least Vehicle Traffic" to be the most important, followed by "Availability of Bicycle Facilities" in second and "Shortest Distance" in a close third. When examined more closely among riding level, "Strong and Fearless" commuting riders are least sensitive to the amount of vehicle traffic, while "Confident" and "Concerned" riders are increasingly more sensitive to the amount of vehicle traffic. This follows common logic and can been seen in

Table 27, Table 28, and Table 29 as the "rating" (or weighted average) of the vehicle traffic aspect increases as the riding level decreases (3.58 < 3.92 < 4.64). Additionally the route distance becomes increasingly less important to riders as their riding level decreases (3.67 > 3.37 > 2.64).

Table 27: Route Choice Criteria among "Strong and Fearless" Commuters

"Strong and Fearless" Commuters

Route Criteria	Average Rating
Shortest Distance	3.67
Vehicle Traffic	3.58
Bicycle Facilities	3.27
Terrain/Hills	2.73
Attractions	1.75

n=291

Table 28: Route Choice Criteria among “Enthused and Confident” Commuters

"Enthused and Confident" Commuters

Route Criteria	Average Rating
Vehicle Traffic	3.92
Bicycle Facilities	3.87
Shortest Distance	3.37
Terrain/Hills	2.56
Attractions	1.27

n=204

Table 29: Route Choice Criteria among “Interested but Concerned” Commuters

"Interested but Concerned" Commuters

Route Criteria	Average Rating
Vehicle Traffic	4.64
Bicycle Facilities	3.76
Shortest Distance	2.64
Terrain/Hills	2.64
Attractions	1.32

n=25

In the scenario where bicycle lanes and other facilities are available among all possible routes (controlling for bicycle lanes), different results occur. As shown in Table 12, shortest distance becomes the most important criterion for commuters, over that of vehicle traffic. Overall commuter behavior in this scenario is similar to the most confident riders when bicycle lanes may not be present. This demonstrates that riding in bicycle lanes and on other bicycle facilities gives commuting bicycle riders more confidence and a greater sense of safety from vehicle traffic.

Table 30, Table 31, and Table 32 show the results for commuters among different riding levels. Again, sensitivity to vehicle traffic increases as riding level decreases (2.69 < 2.90 < 3.36). Only the "Interested but Concerned" riders still rate vehicle traffic as the most important aspect over shortest distance even with the presence of bicycle facilities; however, the net difference between the two decreased greatly from 2.00 to 0.68.

Table 30: Route Choice Criteria among "Strong and Fearless" Commuters with Bicycle Facilities on All Routes

"Strong and Fearless" Commuters

Route Criteria	Average Rating
Shortest Distance	3.25
Vehicle Traffic	2.69
Terrain/Hills	2.41
Attractions	1.65

n=291

Table 31: Route Choice Criteria among "Enthused and Confident" Commuters with Bicycle Facilities on All Routes

"Enthused and Confident" Commuters

Route Criteria	Average Rating
Shortest Distance	3.26
Vehicle Traffic	2.90
Terrain/Hills	2.50
Attractions	1.34

n=204

Table 32: Route Choice Criteria among “Interested but Concerned” Commuters with Bicycle Facilities on All Routes

"Interested but Concerned" Commuters

Route Criteria	**Average Rating**
Vehicle Traffic	3.36
Shortest Distance	2.68
Terrain/Hills	2.64
Attractions	1.32

n=25

Examining the same scenarios among recreational and leisure riders yields similar results with a few differences. Again, as the riding level decreased the sensitivity to vehicle traffic increased (4.61 < 4.81 < 5.01). As riding level decreases, the riders’ desire to use bicycle facilities increased (3.38 < 4.28 < 4.33). Additionally, while “best workout” is the most important criterion to “Strong and Fearless” riders, it is not as important as vehicle traffic and bicycle facilities to less confident riders. This shows that the primary concern of both “Enthused and Confident” and “Interested but Concerned” riders is safety over the best workout and scenery (“Attractions”). These results can all be seen in Table 33, Table 34, and Table 35.

Table 33: Route Choice Criteria among “Strong and Fearless” Recreational and Leisure Riders

"Strong and Fearless" Recreational

Route Criteria	Average Rating
Best Workout	4.71
Vehicle Traffic	4.61
Attractions	3.44
Bicycle Facilities	3.38
Terrain/Hills	2.95
Shortest Distance	1.91

n=150

Table 34: Route Choice Criteria among “Enthused and Confident” Recreational and Leisure Riders

"Enthused and Confident" Recreational

Route Criteria	Average Rating
Vehicle Traffic	4.84
Bicycle Facilities	4.28
Best Workout	3.45
Terrain/Hills	3.15
Attractions	3.05
Shortest Distance	2.23

n=130

Table 35: Route Choice Criteria among “Interested but Concerned” Recreational and Leisure Riders

"Interested but Concerned" Recreational

Route Criteria	Average Rating
Vehicle Traffic	5.01
Bicycle Facilities	4.33
Terrain/Hills	3.33
Best Workout	3.09
Attractions	3.04
Shortest Distance	2.21

n=107

Results among recreational/leisure riders if bicycle facilities were available along all possible routes were very similar to those without facilities. Again, only the “Strong and Fearless” riders considered “best workout” to be the most important aspect of route choice, with each of the less confident groups of riders rating vehicle traffic as the most important aspect. These results are seen in Table 36, Table 37, and Table 38.

Table 36: Route Choice Criteria among “Strong and Fearless” Recreational and Leisure Riders with Bicycle Facilities on All Routes

"Strong and Fearless" Recreational

Route Criteria	Average Rating
Best Workout	4.08
Vehicle Traffic	3.41
Attractions	3.16
Terrain/Hills	2.59
Shortest Distance	1.77

n=150

Table 37: Route Choice Criteria among "Enthused and Confident" Recreational and Leisure Riders with Bicycle Facilities on All Routes

"Enthused and Confident" Recreational

Route Criteria	Average Rating
Vehicle Traffic	3.61
Terrain/Hills	3.06
Best Workout	3.05
Attractions	2.89
Shortest Distance	2.38

n=130

Table 38: Route Choice Criteria among "Interested but Concerned" Recreational and Leisure Riders with Bicycle Facilities on All Routes

"Interested but Concerned" Recreational

Route Criteria	Average Rating
Vehicle Traffic	3.99
Attractions	2.95
Terrain/Hills	2.94
Best Workout	2.85
Shortest Distance	2.26

n=107

6.4 Shared-Lane Facilities

Section 5.5 first presented how riders responded to different traffic scenarios given several different treatments (and one with no treatments) in shared-lane situations.

The intent of this section is to analyze these results more closely so that general behaviors of bicyclists can be gathered and applied to future designs. When presented as a whole, it becomes apparent that the higher the speed and/or volume of traffic, the less confident bicyclists are to ride in the center of the roadway or even towards the right but still safely out of the door-zone of parked vehicles. As traffic speed and volume increase, the moving vehicle traffic becomes more of a concern to bicyclists than a parked car opening a door.

Each of the treatments presented can be seen in the images in Chapter 2. The roadway pictured is a “narrow” roadway, with no room for bicyclists and vehicles to operate safely side by side without the threat of a bicycle collision with a parked car door. This “narrow” roadway situation was presented to survey takers in order to determine their sensitivity to parked cars as well as moving traffic.

Figure 16 shows the rider positioning on a standard street with curbside parking and no bicycle treatment as a control for comparison. It clearly demonstrates as traffic volume and speed increase riders are less likely to ride in the middle of the traffic lane as well as towards the right but safely out of the “door-zone”.

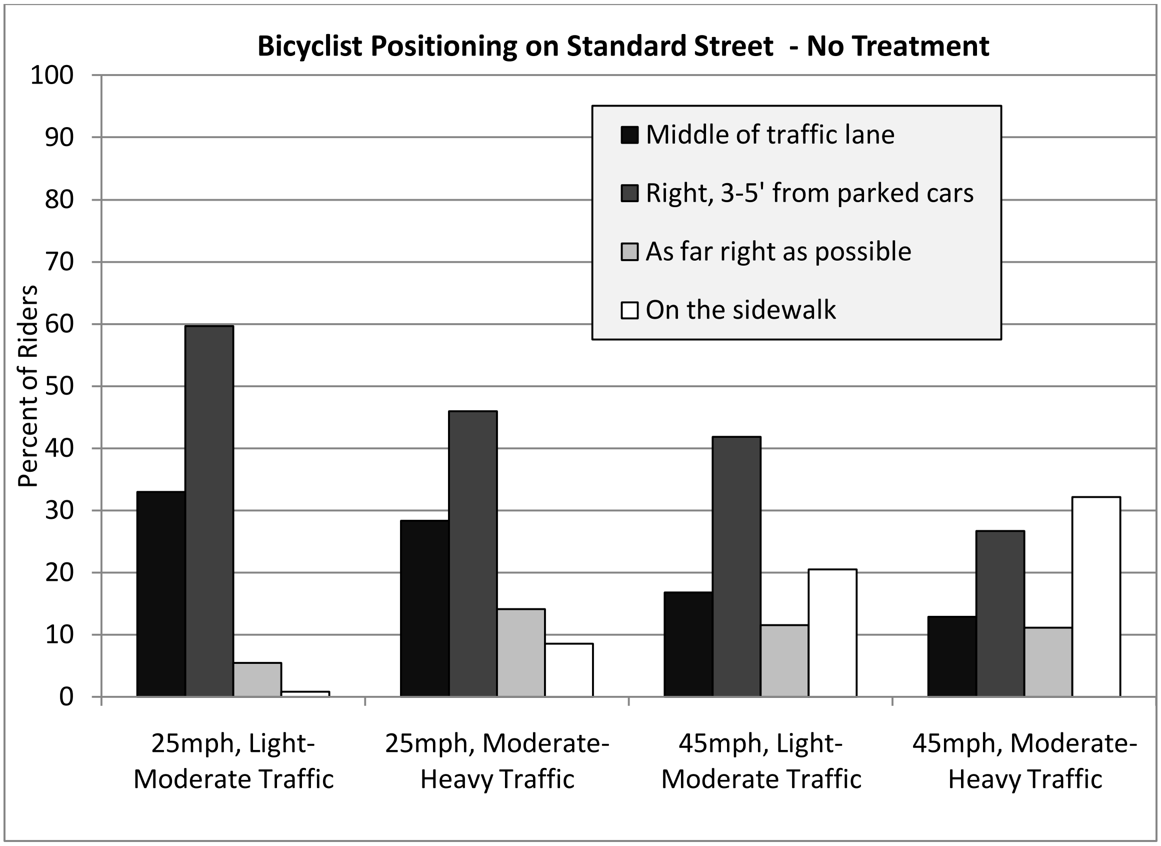


Figure 16: Bicyclist Positioning on Standard Street with No Bicycle Treatment

The next treatment users were asked about was the sharrow. Figure 17 shows slightly more riders using the middle of the lane with a sharrow present than with no treatment. Also, significantly more riders feel confident to ride in line with the sharrow (in what is about the 3-5' from parked cars position previously). Sidewalk riding is reduced with the sharrow as well as bicyclists riding as far to the right as possible in the door zone. In all traffic scenarios, except 45mph with moderate to heavy traffic, the largest portion of bicyclists reported they would ride on the sharrow with its presence on the pavement. This could be seen as communicating to bicyclists where they should ride, but is probably due more to bicyclists feeling more confident that motorists would expect them and see them given the presence of the pavement marking. A bicyclist who knows where he or she is *supposed* to ride still may not ride there due to concerns over vehicle traffic. This is clearly supported by a reduction of 20% of bicyclists riding on the sharrow in the final traffic scenario when all other factors remain constant.

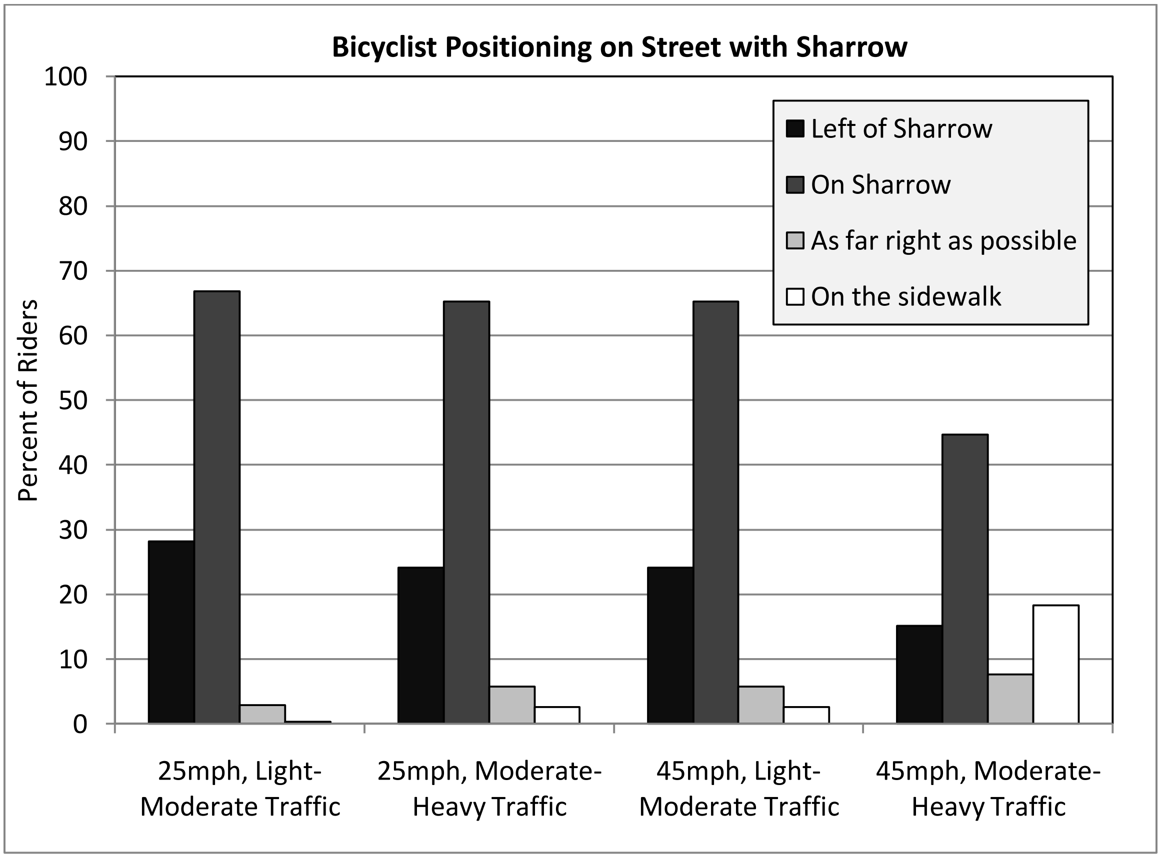


Figure 17: Bicyclist Positioning on Street with Sharrow treatment

The next treatment in the survey was the Sharrow BPL, or Bicycle Priority Lane. The results in Figure 18 show a significant increase in bicyclists that utilize the treatment over a standard sharrow. Improvements in the two 25-mph traffic scenarios were 17.8% and 13.8% respectively more bicyclists riding in the treatment than in the standard sharrow. There was also an improvement of 9.3% more riders (overall) using the Sharrow BPL in the highest volume and speed scenario, accounting for a 54.0% majority. Each speed scenario saw similar increases in sidewalk riding as traffic speed and volume increased, as well as increases of bicyclists riding as far right as possible (in the door-zone).

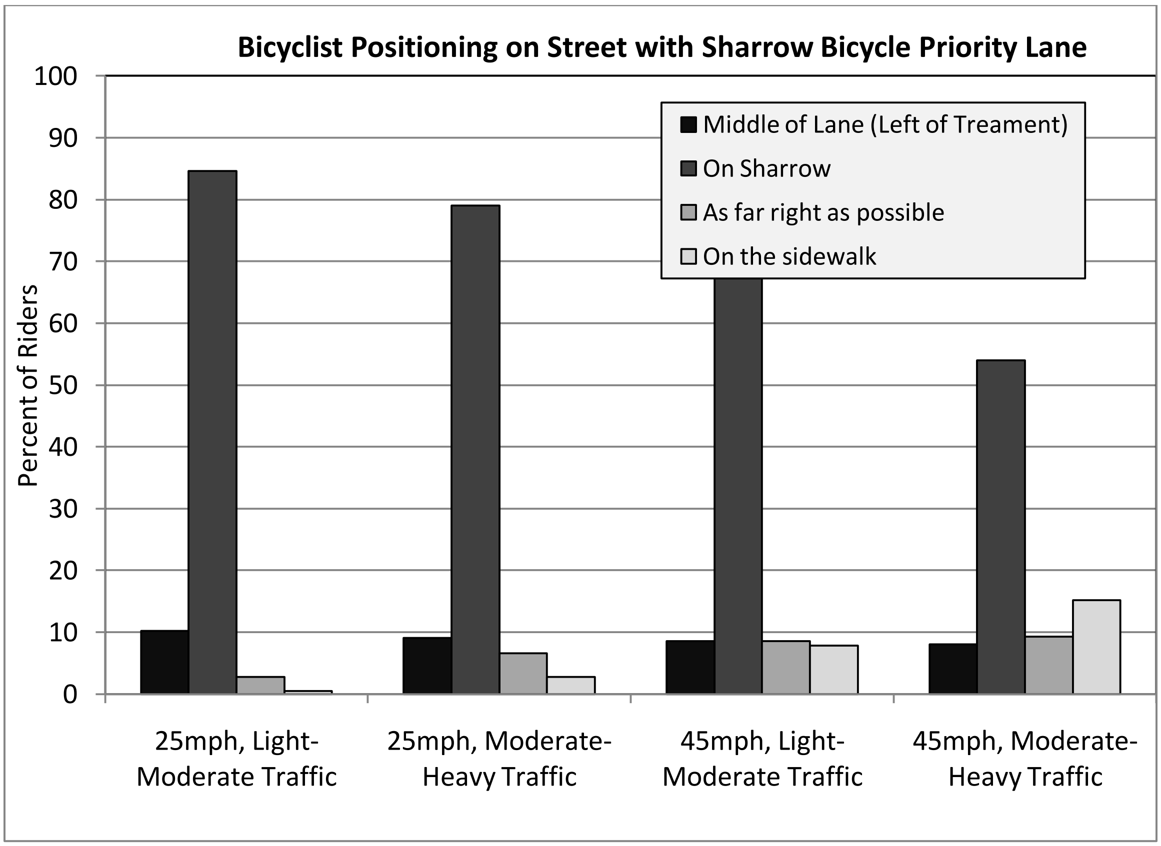


Figure 18: Bicyclist Positioning on Street with Sharrow Bicycle Priority Lane

The final pavement parking treatment in shared-lane situations is the Green BPL. The results are shown in Figure 19. Again with the increase in pavement marking (and color for this treatment) a higher percentage of riders are willing and confident to ride in the treatment and safely out of the door zone and off the sidewalks. Of each of the shared-lane pavement markings (Sharrows, Sharrow BPL, and Green BPL), the Green BPL had the highest percentage of bicyclist utilization in all traffic scenarios. In each of the traffic scenarios, a large majority of the surveyed bicyclists responded that they would ride within the green lane.

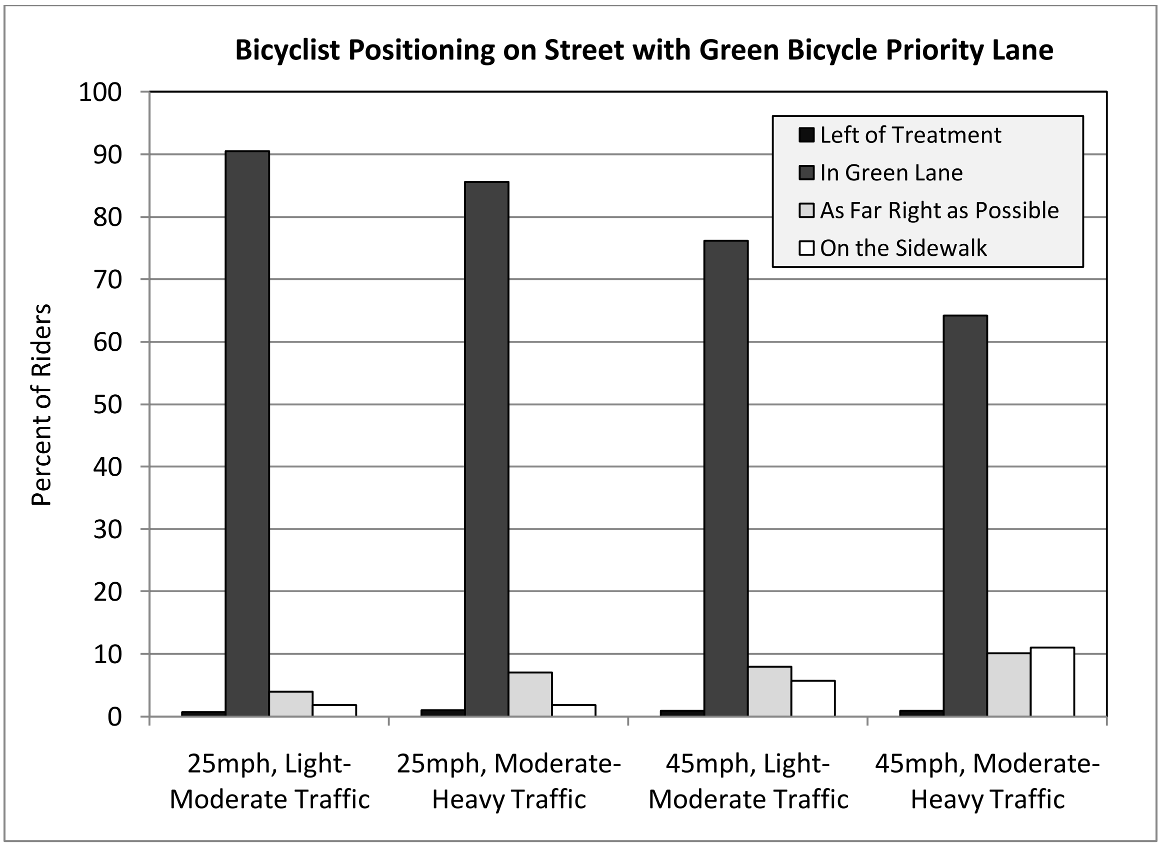


Figure 19: Bicyclist Positioning on Street with Green Bicycle Priority Lane

The next two figures show the results for the two MUTCD-approved signs included in the bicyclist survey. The results for the "Share the Road" sign (see Figure 20) are only slightly different than the standard street with no treatment. While the percentage of bicyclists riding on the sidewalk is reduced and bicyclists riding 3-5' from parked cars is increased in all traffic scenarios, there is also a reduction in bicyclists riding in the middle of the roadway (when compared with no treatment). It seems to go against intuition that bicyclists would be less confident to ride in the middle of the roadway with this sign in place. These results show that many bicyclists then understand this sign to mean that "sharing" the road involves not riding in the middle of the lane and instead allowing more vehicles to pass when safe. While the intention of the sign is to alert motorists that they should share the road with bicyclists, it seems that bicyclists also interpret it to mean they should share the road with motorists. Overall, this sign does not have as large of an effect as the sharrow, Sharrow BPL, or Green BPL.

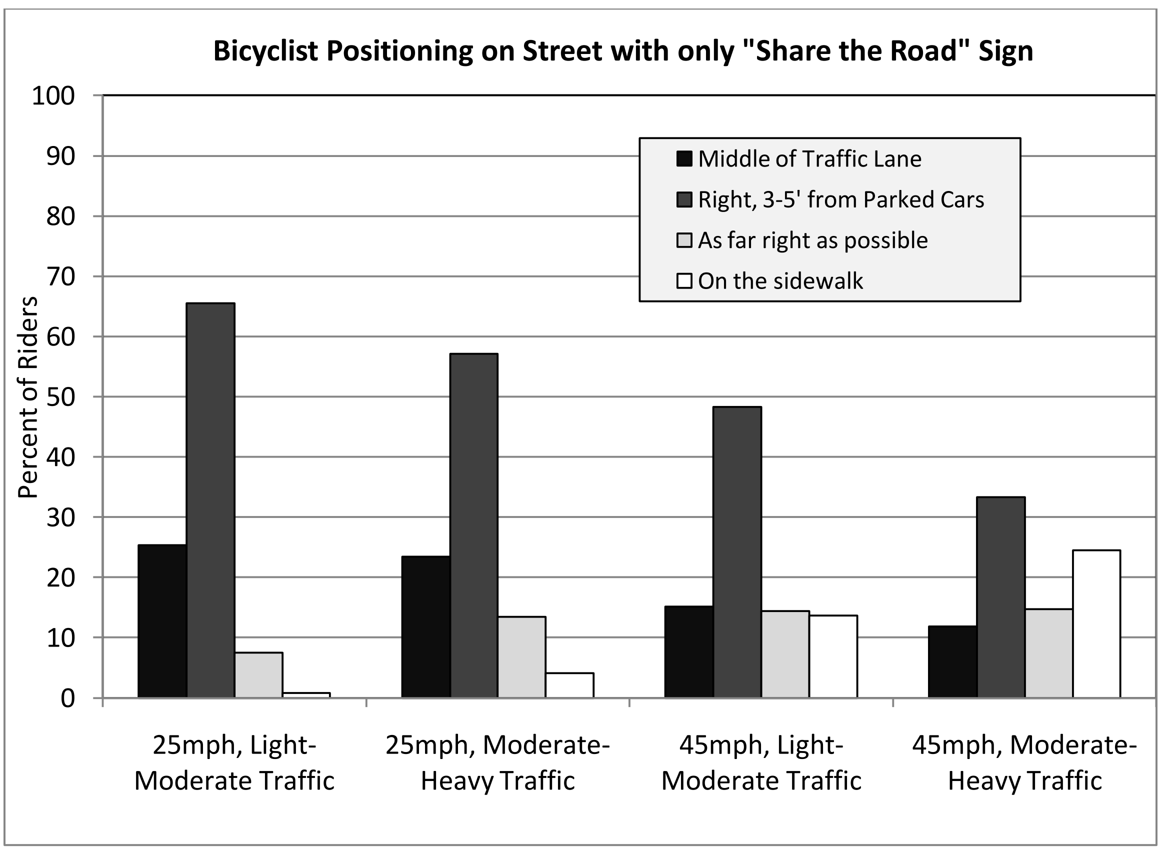


Figure 20: Bicyclist Positioning on Street with Only a "Share the Road" Sign

The “Bicycles May Use Full Lane” sign, commonly abbreviated as BMUFL, has a different effect than the “Share the Road” sign (see Figure 21). This sign saw an increase in the percentage of bicyclists who would use the middle of the traffic lane in all four traffic scenarios over both the “Share the Road” sign as well as with no treatment. However, this sign alone does not appear to give all bicyclists confidence to in fact use the full traffic lane, as no more than 40% of respondents said they would use the middle of the traffic lane, even in the slowest and lightest of the presented traffic scenarios. The BMUFL sign did see a decrease in sidewalk riding in all scenarios over both the “Share the Road” sign and no treatment (except the 25-mph Light-Moderate traffic scenario, surprisingly). This sign does seem to effectively convey its meaning to riders as evidenced by the increase in bicyclists who would use the middle of the lane.

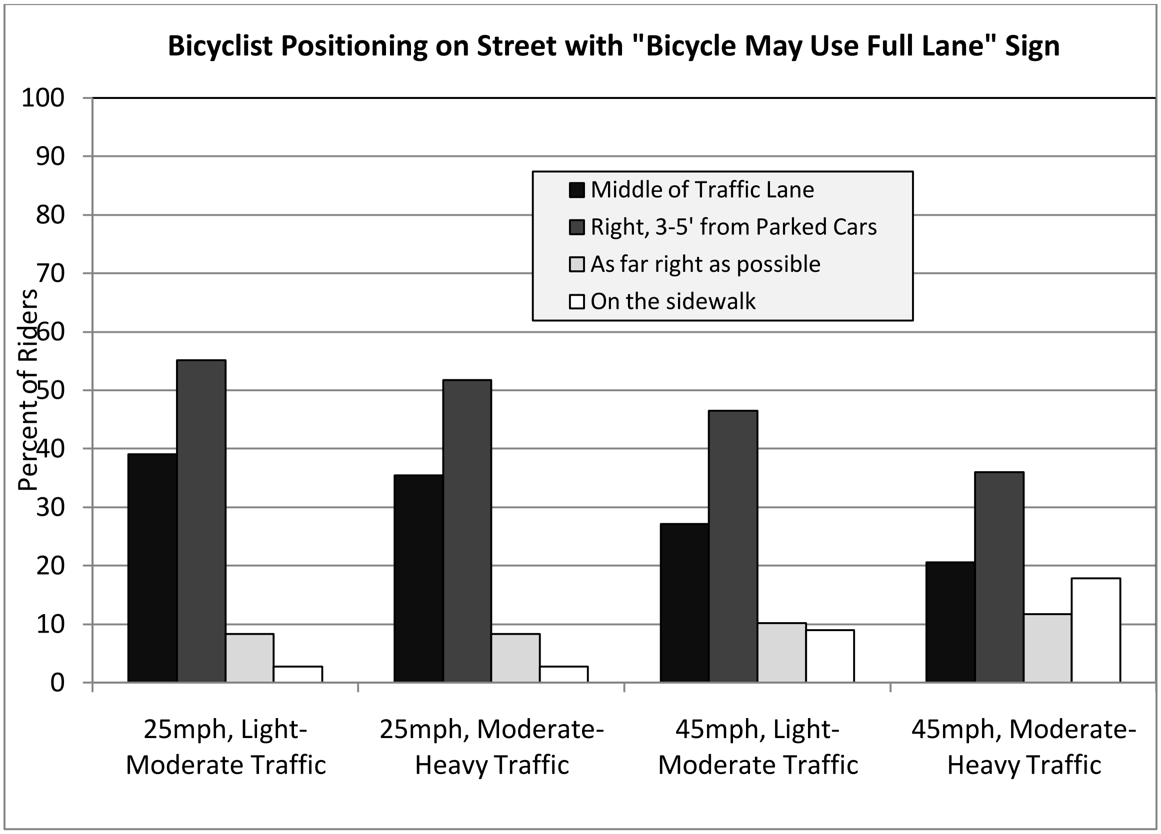


Figure 21: Bicyclist Positioning on Street with Only a "Bicycles May Use Full Lane" Sign

After evaluating the results and effectiveness of each of the shared-lane treatments separately, some comparative effects can be seen. The presence of a treatment on the pavement in the form of a painted marking has a greater effect than does a sign spaced evenly along a roadway. The "least effective" of the lane markings, the sharrow, still had a greater effect than the "most effective" sign, the BMUFL, at giving bicyclists confidence to ride either in the middle of the roadway or in the middle of the traffic lane and safely off of the sidewalk and out of the door-zone of parked vehicles. Among the lane marking treatments – the sharrow, Sharrow BPL, and Green BPL – there was a noticeable trend that as the visibility and size of the marking on the roadway increased, so would the confidence of bicyclists to ride in the middle of the lane and 3-5’ from parked vehicles out of the door-zone. Both of the bicycle priority lanes had the greatest effect on rider positioning, largely due to the treatment looking and “feeling” more like a specific lane for bicyclists, even when in the middle of a traffic lane.

Bicyclists appear to be more confident when a lane treatment specifies their position through a lane marking rather than through the use of a sign. This effect could be contributed to bicyclists’ perceived self-belief that they will be better seen and expected by motorists when a pavement marking is present. This idea also holds true since the bigger and more visible the treatment, such as with added lines in the Sharrow BPL and added color in the Green BPL, the more confidence bicyclists have that they will be seen and expected by motorists.

It was apparent through this section of the survey that some bicyclists will often ride in the same location on the roadway, regardless of facilities. Using the open comment box for each of the positioning questions many riders made this point. Some feel most confident when riding towards the left side of the traffic lane, straight in front of an approaching motorist’s line of sight. Other less experienced and slower bicyclists will use the sidewalk in all situations, lacking the confidence that motorists will yield to their slow speeds in the roadway. Many bicyclists responded that they will ride “as far right as possible” even with the presence of parallel parking in various scenarios. The percentage of bicyclists that said they would ride here increased as the speed and volume of traffic increased. While some bicyclists who do not ride regularly in urban settings with on-street parallel parking may not be aware of the hazards of getting “doored” by an opening car door, the growth in this category in each traffic scenario shows that many are in fact aware of it and still choose to ride here. This shows that these bicyclists perceive the danger from oncoming vehicles behind them to be greater than the danger of getting “doored” by parked vehicles, especially at the lower speeds of many less confident and experienced bicyclists.

Many of the surveyed riders chose to ride on any roadway bicycle treatment and expect drivers to yield to them at all times. This “style” of riding could be a geographically specific response, as some cities are traditionally more “bicycle-friendly” (such as Portland, Oregon) [19] whereas others are seen as more hostile roadways for bicyclists (such as the author’s own Atlanta, Georgia). While the author desired to determine if the geographical location of each of the surveyed bicyclists had an effect on their roadway positioning and riding confidence, there was not an even enough distribution of the survey respondents among cities to fall reasonably within the scope of this thesis.

6.5 Bicycle-Specific Facilities

The bicycle-specific facilities section did not include a standard bicycle lane as a control, as most bicyclists are familiar with them and this report is focused more on innovative techniques. Instead, through the use of a green lane with and without the accompanying white bicycle lane markings (see Figure 2 and Figure 3 from Chapter 2), the effect of these lane markings can be analyzed. While from Figure 22 and Figure 23 it can been seen that there is little difference between the two, the green lane *with* the accompanying white bicycle markings does have a higher percentage of bicyclist utilization than does the lane without the markings. This would lead one to believe that some of the surveyed bicyclists did not understand that the green lane without markings is in fact a bicycle lane. It could also be interpreted to mean that some riders feel more confident to use the lane with markings as both parked and passing vehicles will be more aware of bicyclists because of the addition of the lane markings.

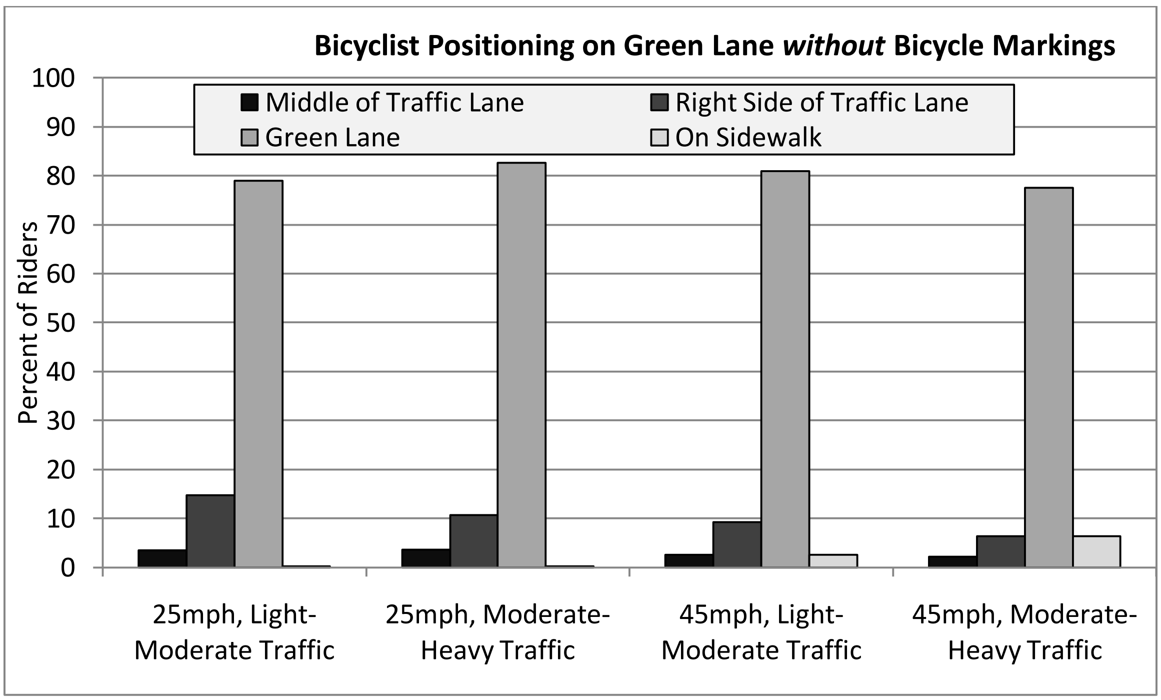


Figure 22: Bicyclist Positioning on Green Lane without Bicycle Markings

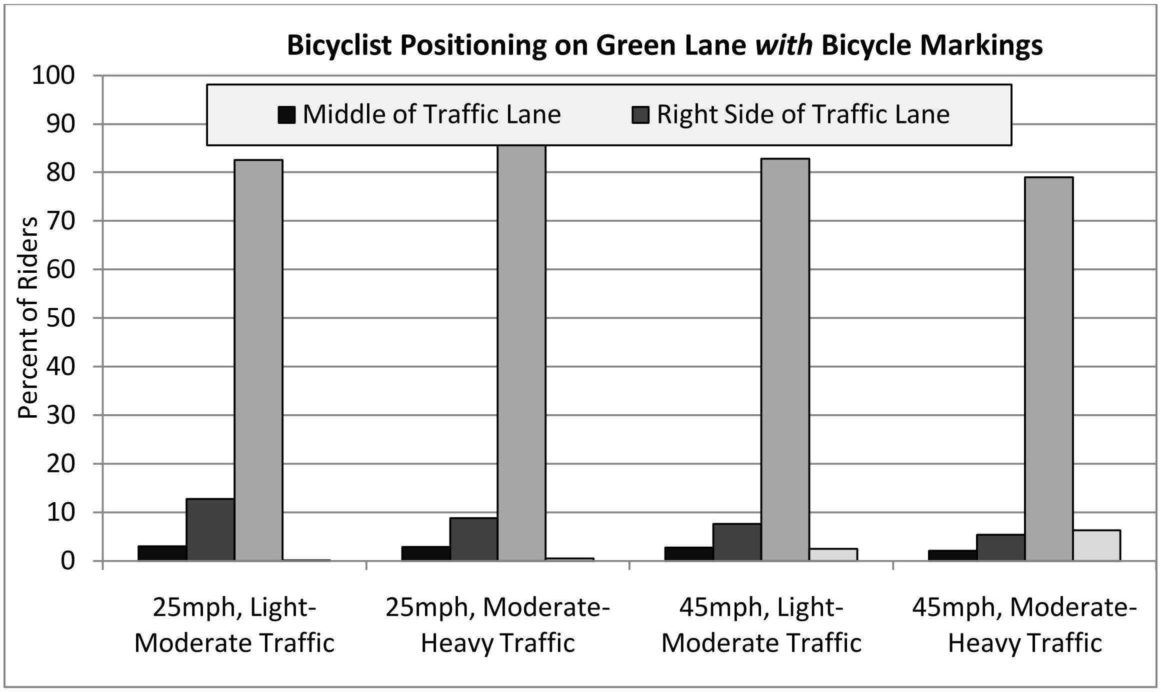


Figure 23: Bicyclist Positioning on Green Lane with Bicycle Markings

6.6 Bike-Box Results

The bike-box was designed with the intent to put bicyclists more clearly within the field of vision of stopped motorists by placing bicycles farther forwards in relation to vehicles when stopped at an intersection. Figure 13 in Chapter 5 shows the five different areas the surveyed bicyclists could respond to as their stopping location. Sections C, D, and E are all the forward position where bicyclists can be better seen by motorists. However, Section E is in the crosswalk where bicyclists should not stop in order to allow enough room for pedestrians to cross. Thus the desired stopping location would be both Section C and Section D.

The first situation is when the bicycle lane does continue on the opposite side of the intersection. The second situation presented is when the bicycle lane does not continue across the intersection. In the first situation the highest percentage bicyclists responded that they would stop in Section D, which is within the boundaries of the original bike lane and is the expected stopping place since the bicycle lane continues across the intersection. There is a noticeable difference in stopping locations in the second scenario when the bike lane does not continue. In this scenario the majority of bicyclists instead responded that they would stop in Section C immediately in front of motorists to establish their riding position before crossing the intersection. For bicyclists who wish to ride in the middle of the traffic lane or 3-5' from parked vehicles on the other side, stopping in Section C is the best way to "take the lane" while motorists and bicyclists are both stopped. This difference between the first and second scenarios is a good example that shows how bicyclists would change their riding position based on whether or not there is a bicycle lane present across the intersection. The difference between bicyclists that said they would stop in Section C versus Section D between the two scenarios is a net change of 34.5%. This is the proportion of riders that would change their riding behavior between the two correct stopping locations based on the presence of the bike lane across the intersection. In each scenario similar proportions of riders said that they would stop in Section A, Section B, or Section E (3.5%, 2.9%, and 2.4% respectively for the first scenario and 4.1%, 3.3%, and 2.9% respectively for the second). It is assumed that these bicyclists either do not understand the purpose of the treatment, it does not convey its meaning clearly enough to these bicyclists, or they simply choose not to stop in the desired location.

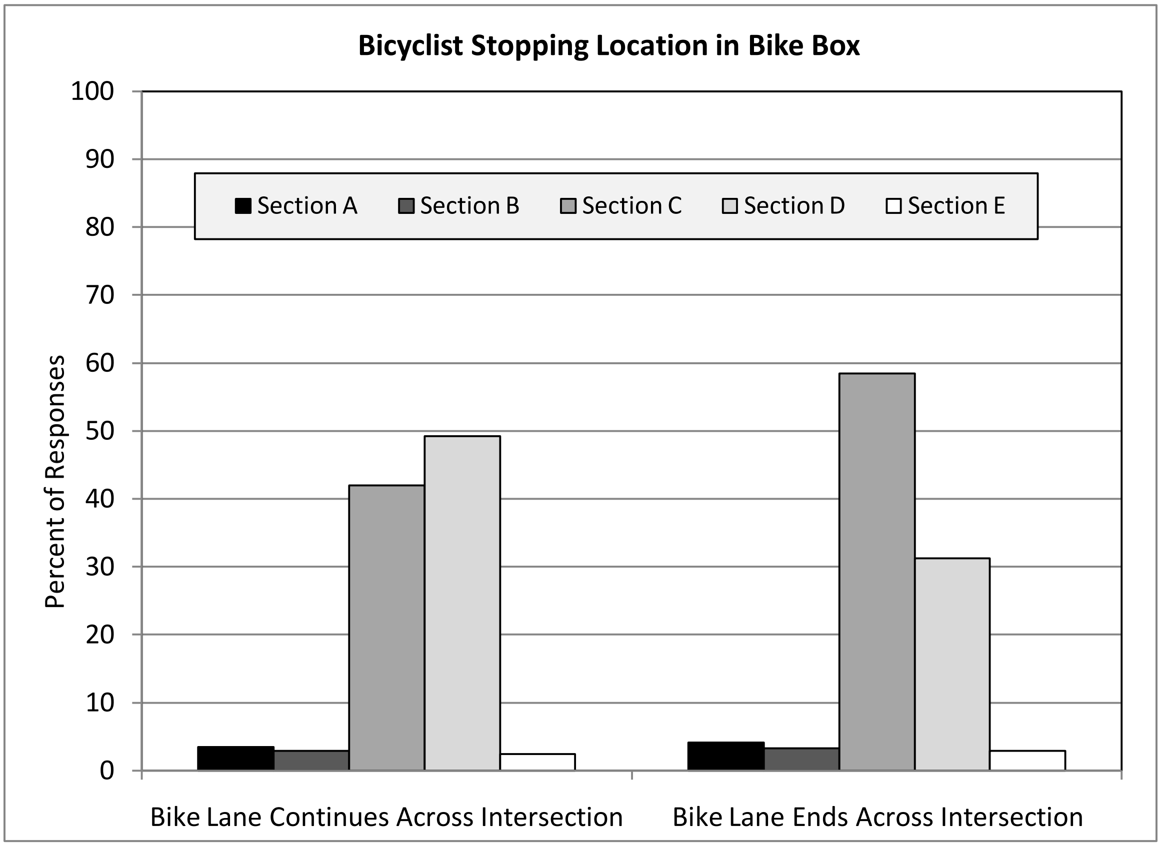


Figure 24: Bicyclist Stopping Position in Bike-Box

6.7 User Preference of Treatments

The final section asked survey respondents to rate each of the treatments in order after their purpose and meaning was explained in previous section. Again the comparisons were made in the three different categories of treatments: shared-lane situations, bicycle-specific facilities, and high-conflict area treatments. This section can give traffic engineers valuable information as to which roadway treatment should be chosen when comparing different options.

Each category is shown with an accompanying graph of its ratings among users. These ratings are a weighted average between 1 and the number of treatments (so a comparison of 4 treatments could be rated from 1 to 4). The middle column in each situation is the weighted average rating among all 1000 survey respondents. The left and right columns are the maximum and minimum average ratings of each treatment among the following 10 user groups:

- Riding purpose: commuting, shopping/social, or recreation/leisure
- Home area: urban-CBD, urban non-CBD, suburban, or rural
- Riding level: “Strong and Fearless”, “Enthused and Confident”, or “Interested but Concerned”

As can be seen in Figure 25, among the shared-lane situation treatments a clear order developed among those surveyed. This order from most preferred to least is:

1. Green Bicycle Priority Lane,
2. Sharrow Bicycle Priority Lane,
3. Sharrows,
4. “Bicycles May Use Full Lane” sign, and
5. “Share the Road” sign.

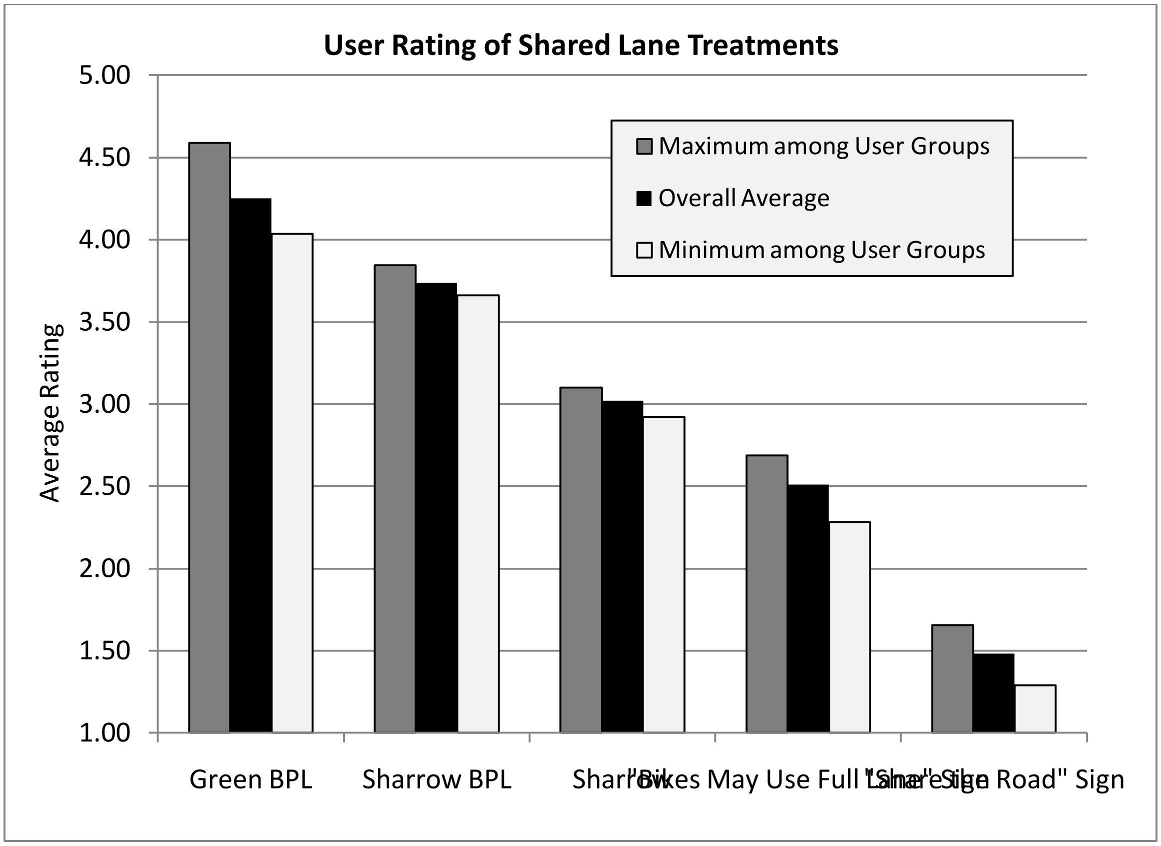


Figure 25: User Rating of the Five Compared Shared-Lane Situation Treatments

The maximum and minimum average ratings among the analyzed user groups show how consistent the preference order is for each, as the minimum average rating for a treatment for any group is not lower than the maximum for the next treatment. These results again help demonstrate how pavement markings are more preferred than signage only, and how the more visible the treatment on the roadway is, the more preferred it will be by bicyclists.

An examination of the surveyed bicyclists' preference among bicycle-specific lane treatments also revealed a strong preference order (see Figure 26). This order from most preferred to least preferred is:

1. Green bike lane, with markings
2. Standard bike lane (no color), with markings
3. Green bike lane, without markings

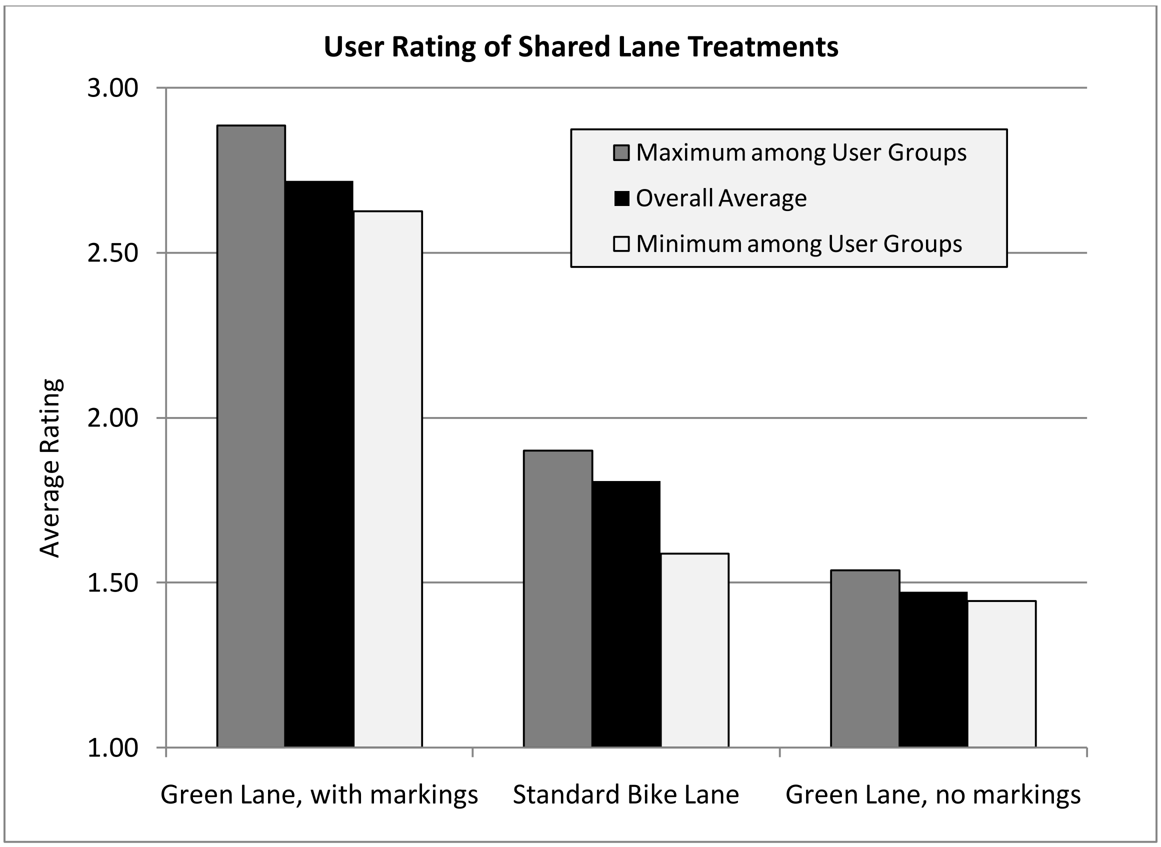


Figure 26: User Rating of the Three Compared Bicycle-Specific Facility Treatments

Again as was the case with the shared-lane treatments, the preference has a strong order as evidenced that no minimum average rating for one treatment is less than the maximum average rating for the next. This situation again demonstrates how more markings and color are preferred by bicyclists over less “visible” treatments. The green lane with markings was a clear favorite over both alternatives. This result also shows the importance of the lane markings to bicyclists, as they rated a standard lane with markings as preferred even over a green lane without markings. Color in this case is not the most important characteristic of a treatment in this scenario, but instead clearly marked facilities are more preferred.

The final comparison is among three high-conflict area treatments introduced to the respondents in the preceding section: green colored lane areas, “elephant footprints”, and the AASHTO-recommended dashed lines [6]. Again a clear order preference emerges when the results are analyzed (see Figure 27). This order from most-preferred to least-preferred is:

1. Green colored area of bicycle lane
2. “Elephant footprint” markings
3. Dashed lines
4. No special treatment

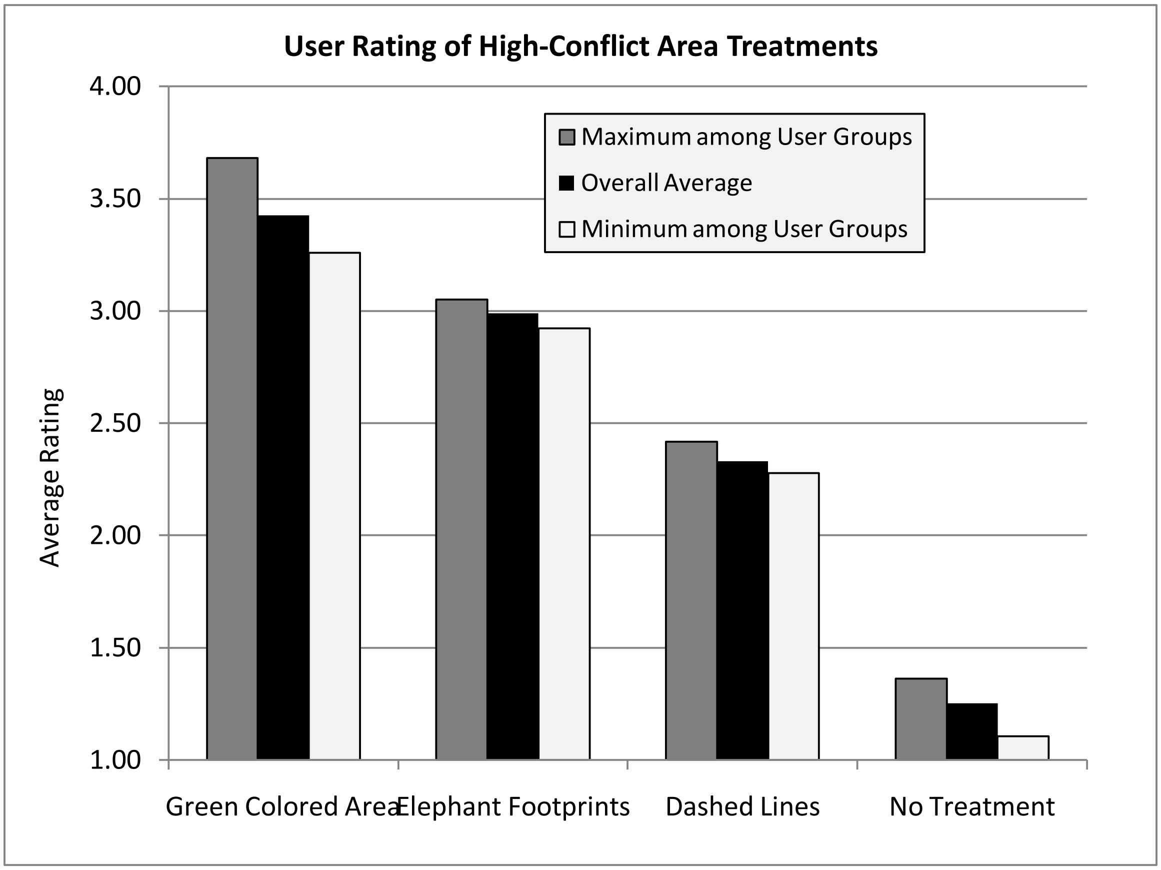


Figure 27: User Rating of the Compared High-Conflict Area Treatments

With these high-conflict area treatments a bicycle lane is present both before and after the treated area, thus a majority of bicyclists would be riding in the same position before, through, and after the treated area. A bicyclist's preference in this situation is completely a measure of how confident they feel motorists will see and yield to a bicycle in that treated area.

Again as was the case with the previous two treatment categories, the preference has a strong order as evidenced that no minimum average rating for one treatment is less than the maximum average rating for the next. This situation demonstrates once more how more markings and color are preferred by bicyclists over less “visible” treatments. The surveyed bicyclists must then feel safer in the green colored area first, and with elephant footprints second. Both of these treatments are not seen often (if at all) in the United States; these results demonstrate how bicyclists feel these more visible “unorthodox” treatments will gain the attention of motorists better than simple dashed lines.

The results of each of the three categories of innovative bicycle treatments demonstrated that users prefer more visible pavement markings over less visible markings and signage. In each scenario the most preferred treatment involved adding a green color to the roadway. Bicyclists feel that this treatment best alerts motorists to look for and yield to bicycles on the roadway. However the green pavement paint in each scenario adds additional costs to implementing these treatments, both on initial application and with maintenance. Pavement markings that are regularly driven over by vehicles wear away faster than other markings. Several of these treatments include markings in locations in the tire track of most vehicles (such as the sharrow and the bicycle priority lanes) and thus will wear away faster than other pavement markings.

The fading of the green color and white pavement markings leads to a large reduction in visibility over time, and thus rendering these treatments less effective. It is the high visibility of these treatments that give bicyclists more confidence they’ll be seen and yielded to by motorists. Regular maintenance of these facilities then becomes an important issue regarding the continued safety benefits of each. While the green treatments in each scenario are most preferred and effective, any agency considering implementation of such lanes should also consider and plan for the accompanying maintenance costs with each treatment.

CHAPTER 7: CONCLUSIONS

7.1 Conclusions

This study was motivated by the desire to expand the knowledge and research on these various innovative bicycle infrastructure treatments. Many different treatments were considered and studied in order to determine how bicyclists understand and respond to them in different given traffic scenarios. In addition rider characteristics were examined showing different riding purposes and levels, which in turn can help engineers and planners understand why some bicyclists respond differently than others in the same situations. Finally an order was determined among the sampled bicyclists as to which of these innovative treatments they would most desire to ride on.

The surveyed sample of bicyclists included a larger portion of "Strong and Fearless" and "Enthused and Confident" riders than the population sampled in the Portland, OR study with the same definitions of riding level. Thus the results of this research effort as a whole reflect the responses of a more aggressive sample of bicyclists, yet results on a per-riding-level basis reflect the differences between each.

A majority of the bicyclists that revealed their primary purpose as commuting are riding at least 2-5 miles one-way at least four times a week, rather than riding short-distances irregularly. This demonstrates how it is important to create and/or maintain a well-connected system of bicycle facilities in order to promote this behavior and ensure its safety.

When bicyclists were asked how they choose their route, it was revealed that the most confident riders consider minimum route distance to be the most important. However, as riding level decreases, the amount of vehicle traffic then becomes the most important route characteristic for bicyclists. This relationship is even true in the presence of bicycle facilities for the least confident bicyclists. This reveals the importance of placing bicycle facilities along specifically chosen routes to maximize use, as bicycle facilities on heavily vehicle trafficked routes still won’t appeal to all riders. Figure 28 and Figure 29 both give a graphic example of these trend relationships. (Both relationships are depicted as linear relationships for visual clarity, but are not necessarily linear in nature.)

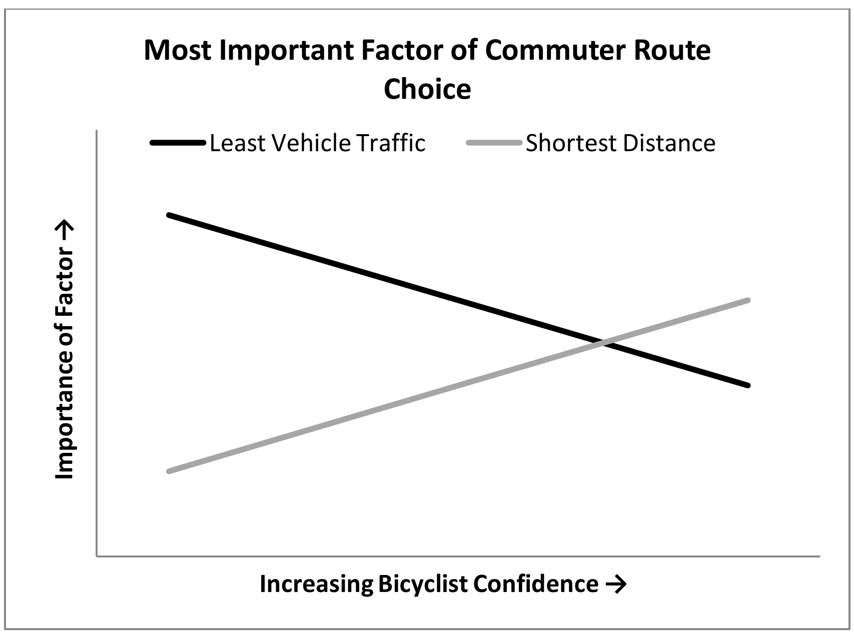


Figure 28: Relationship between Route Selection and Bicyclist Confidence

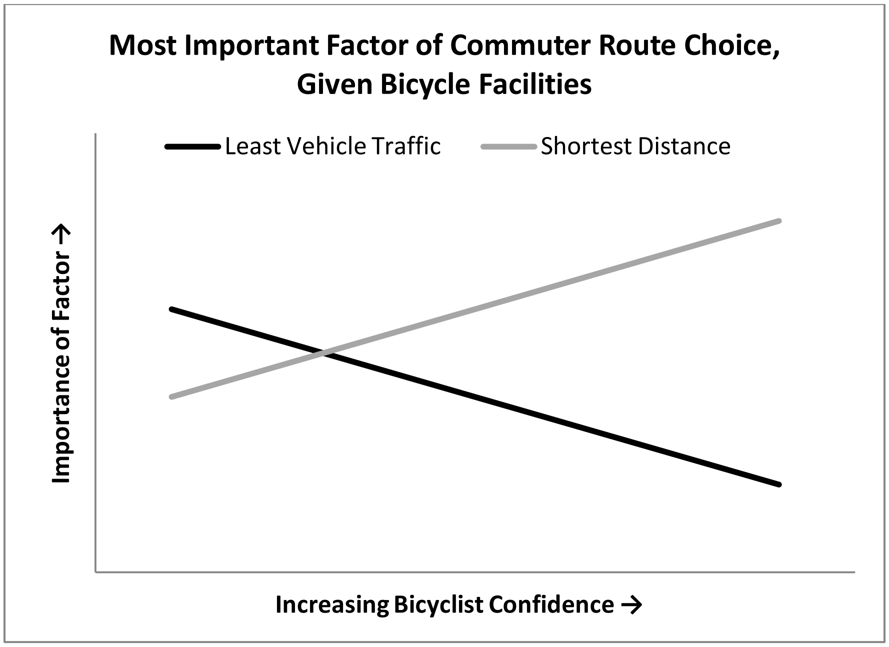


Figure 29: Relationship between Route Choice and Bicyclist Confidence Given Bicycle Facilities

In each situation presented as traffic speed and volume increased, more bicyclists would ride far to the ride or on the sidewalk. This shows that these bicyclists are more sensitive to the dangers of moving vehicle traffic than the dangers of parked vehicle doors (when riding to the right) or of pedestrian conflicts (when riding on the sidewalk).

This would lead one to believe that some of the surveyed bicyclists did not understand that the green lane without markings is in fact a bicycle lane. It could also be interpreted to mean that some riders feel more confident to use the lane with markings as both parked and passing vehicles will be more aware of bicyclists because of the addition of the lane markings.

From each set of treatments a clear relationship developed demonstrating how bicyclists are more likely to use a treatment as its visibility is increased. While the coloring of some signage can be changed to add visibility, the surveyed bicyclists would change their positioning more in the presence of a roadway marking than roadside signage. This involved either a larger pavement marking and/or the addition of color to a treatment. The addition of color to a treatment especially had the greatest effect on the positioning of bicyclists by use of the Green Bicycle Priority Lane. The importance of this result is that this treatment experienced the highest percentage of riders across all traffic scenarios that would ride in the same location. Whether riding within the Green BPL is the safest area for a bicyclist does not fall within the scope of this report. However, when more bicyclists ride in the same location, they become more expected and predictable to motorists. Additionally, this has the same effect from the view of the bicyclist. Bicyclists believe that since they are in a more expected location that motorists are more likely to yield to them. The predictability of a bicyclist and his or her position and maneuvers is important to creating a safe situation between the two. It’s seen from this report that the bicycle priority lanes, especially the Green Bicycle Priority Lane will make bicyclists the most predictable in these shared-lane situations, thus increasing their safety.

For more than a third of survey respondents, the presence of a bicycle lane across an intersection affected their positioning within the bike-box. However what is more important is that in either across-intersection scenario, a large majority of riders responded they would stop in front of stopped vehicles yet behind the crosswalk. This again provides a predictability to bicycles as previously mentioned and thus can help create safer situations between motorists and bicyclists.

Regarding user preference of the different shared-lane treatments, results demonstrated a clear preference order. Regardless of rider level/location/purpose, bicyclists most prefer the Green Bicycle Priority Lane to other treatments. The Sharrow Bicycle Priority Lane was the next most preferred followed by the Sharrow. Finally the sign treatments were least preferred, with the “Share the Road” sign being the least preferred over the “Bicycles May Use Full Lane Sign.”

For the bicycle-specific facilities, regardless of rider level/location/purpose, there is again a consistent preference of bicycle-specific lane treatments. The green bike lane was most preferred to the standard bike lane, with the green lane (with no bicycle markings) being the least preferred. This shows how color is still the most preferred treatment, but that the clarity that lane markings provide are still vital to riders as the green lane with no markings could be confusing to roadways users.

Finally, in high-conflict area situations a similar result was obtained. Regardless of rider level/location/purpose, there is a consistent preference of high-conflict area treatments. Bicyclists most prefer the green colored lane to the elephant footprint markings, with the AASHTO-recommended dashed lines [6] being the least preferred of the three (but still preferred over no markings). Again color is the most preferred treatment, with the size of markings (elephant footprints) the next important treatment characteristic.

While in each situation the painted green lane treatment was most preferred and most utilized of all the treatments in each scenario, it may not be the best option for all agencies. The green color will require more maintenance and possibly lose its effectiveness quicker than other non-colored treatments. Any agency considering the use of a green-lane treatment should carefully consider these maintenance costs as a vital part of treatment application.

Many of the results of this effort coincide with the results of the Van Houten et al. study that showed that as the lane markings for bicycle facilities increased, bicyclist positioning would move further left [15]. The same was true in this study as the marking visibility and coloring become more apparent, bicyclists felt more confident to ride further left in the roadway. Also, Dill et al. found that the availability of bike lanes did lead to more bicycling and the desire to ride more by people in the area [16]. When these research efforts are combined, it can be concluded that the addition of more bicycle facilities and lanes that are marked more visibly will result in more people riding bicycles. These riders will then feel more confident to ride further left in the roadway. The addition of more bicyclists riding in the roadway along bicycle facilities increases their predictability, and thus safety as mentioned previously. The Jacobsen study found that bicycling safety increases as numbers increase [17]. From each of these study results in can be concluded that the most effective and preferred innovative bicycle treatments in this study can both increase ridership as well as bicycling safety where implemented.

7.2 Suggestions for Future Research

The goal of this effort was to put more information on these various innovative bicycle infrastructure treatments into the hands of decision makers. This research effort was broad in scope, and thus there is much room for expansion onto this effort regarding more specific situations and scenarios to which these bicycle treatments could be applied. These complimentary efforts could be even more powerful tools for agencies and other decision makers when considering upgrading and/or adding to their bicycle facilities and infrastructure.

Creating a similar survey as this one but intending it for motorists could yield valuable information as to how motorists understand these innovative treatments. It could also help determine how motorists respond to bicyclists in each treatment, if they would yield, and in what circumstances. This was originally desired by the author but the required sample size fell out of the scope of the research efforts. This, however, is still an important piece to bicycling as the expected response of motorists greatly influenced the bicyclist in this survey and how they would use each treatment.

Additional research into geographical response of bicyclists to each treatment could also provide valuable information. Naturally motorists and bicyclists alike respond differently in cities and regions that are considered more "bicycle friendly" than in other regions. Efforts to quantify this when coupled with these innovative treatments could provide unique and informative research.

As more research is completed on these innovative bicycle infrastructure treatments, it will help provide valuable information to agencies and decision makers considering these treatments. Further safety evaluations of each treatment in different applications can help researchers understand each better and which prove to be the safest for bicyclists and motorists alike.

APPENDIX A

The following pages 91-139 show a copy of the online-survey used in this study.

Bicycle Infrastructure Treatments

Thank you for your time to take this survey! You are helping add to research to make our roads safer for bicycles. The survey should take about 15 minutes. Please enter your email address on the final page to be entered into the drawing for the $100 gift card to REI!

Bicycle Infrastructure Treatments

*** 1. What is your gender?**

- Male
- Female

*** 2. What is your age?**

*** 3. Which best describes the area you live in?**

- Urban: CBD (Central Business District)
- Urban: Non-CBD
- Suburban
- Rural

*** 4. Please enter your home zip code.**

*** 5. For which purpose do you use your bicycle most often?**

- Commuting
- Shopping/Social
- Recreation/Leisure

Bicycle Infrastructure Treatments

*** 1. How often do your use your bicycle for commuting to work or school?**

- 4+ times/week
- 1-3 times/week
- 1-3 times/month
- < 1 time/month

*** 2. How long is the total one-way distance for your commute?**

Other

- < 1 mile
- 1-2 miles
- 2-5 miles
- 5-10 miles
- 10+ miles
- It varies

*** 3. How do you normally select the route for your commute? Please rate the following from most important (5) to least important (1).**

	5 - Most Important	4	3	2	1 - Least Important
Shortest distance					
Lowest vehicle traffic					
Availability of bike Other lanes/facilities					
Terrain (least number of hills)					
Attractions/Points of Interest					

*** 4. IF bicycle facilities (i.e. Bike Lanes, Paths, etc.) were available along all possible routes, how would you select your route? Please rate the following in order from most important (4) to least important (1).**

	4 - Most Important	3	2	1 - Least Important
Shortest distance				
Lowest vehicle traffic				
Terrain (least number of hills)				
Attractions/Points of Interest				

Bicycle Infrastructure Treatments

*** 5. Please read the following definitions and classify yourself into one of these types of riders:**

- Strong & Fearless: will ride regardless of facilities(lanes); trip distance is not such an issue
- Enthused & Confident: comfortable in traffic with appropriate facilities (lanes, etc.); prefer shorter trip distances
- Interested but Concerned: not comfortable in traffic; will ride in low traffic volume, low-speed conditions (more residential streets, paths)

Bicycle Infrastructure Treatments

*** 1. How often do you use your bicycle for shopping and/or social trips?**

- 4+ times/week
- 1-3 times/week
- 1-3 times/month
- < 1 time/month

*** 2. How do you normally select the route for your trips? Please rate the following from most important (5) to least important (1).**

	5 - Most Important	4	3	2	1 - Least Important
Shortest distance					
Lowest vehicle traffic					
Availability of bike lanes/facilities					
Terrain (least number of hills)					
Attractions/Points of Interest					

*** 3. IF bicycle facilities (i.e. Bike Lanes, Paths, etc.) were available along all possible routes, how would you select your route? Please rate the following in order from most important (4) to least important (1).**

	4 - Most Important	3	2	1 - Least Important
Shortest distance				
Lowest vehicle traffic				
Terrain (least number of hills)				
Attractions/Points of Interest				

*** 4. Please read the following definitions and classify yourself into one of these types of riders:**

- Strong & Fearless: will ride regardless of facilities(lanes); trip distance is not such an issue
- Enthused & Confident: comfortable in traffic with appropriate facilities (lanes, etc.); prefer shorter trip distances
- Interested but Concerned: not comfortable in traffic; will ride in low traffic volume, low-speed conditions (more residential streets, paths)

Bicycle Infrastructure Treatments

*** 1. How often do you ride your bicycle for recreation and/or leisure**

- 4+ times/week
- 1-3 times/week
- 1-3 times/month
- < 1 time/month

*** 2. How do you normally select the route for your bike rides? Please rate the following from most important (6) to least important (1).**

Other	6 - Most Important	5	4	3	2	1 - Least Important
Shortest distance						
Lowest vehicle traffic						
Availability of bike lanes/facilities						
Terrain (least number of hills)						
Best Workout						
Attractions/Points of Interest						

*** 3. IF bicycle facilities (i.e. Bike Lanes, Paths, etc.) were available along all possible routes, how would you select your route? Please rate the following from most important (5) to least important (1).**

	5 - Most Important	4	3	2	1 - Least Important
Shortest distance					
Lowest vehicle traffic					
Other Terrain (least number of hills)					
Best workout					
Attractions/Points of Interest					

*** 4. Please read the following definitions and classify yourself into one of these types of riders:**

- Strong & Fearless: will ride regardless of facilities(lanes); trip distance is not such an issue
- Enthused & Confident: comfortable in traffic with appropriate facilities (lanes, etc.); prefer shorter trip distances
- Interested but Concerned: not comfortable in traffic; will ride in low traffic volume, low-speed conditions (more residential streets, paths)

Bicycle Infrastructure Treatments

Image 1

*** 1. If you encountered the situation pictured above in IMAGE 1 while on a bicycle, where would you ride? Assume the traffic is LIGHT to MODERATE and the speed limit is 25 MPH.**

Other

- As far to the right as possible
- Towards the right, but about 3-5 feet away from parked cars
- In the middle of the traffic lane
- On the sidewalk
- Not sure
- Other (please specify)

Bicycle Infrastructure Treatments

*** 2. If you encountered the situation pictured above in IMAGE 1 while on a bicycle, where would you ride? Assume the traffic is MODERATE to HEAVY and the speed limit is 25 MPH.**

- As far to the right as possible
- Towards the right, but about 3-5 feet away from parked cars
- In the middle of the traffic lane
- On the sidewalk
- Not sure
- Other (please specify)

*** 3. If you encountered the situation pictured above in IMAGE 1 while on a bicycle, where would you ride? Assume the traffic is LIGHT to MODERATE and the speed limit is 45 MPH.**

- As far to the right as possible
- Towards the right, but about 3-5 feet away from parked cars
- In the middle of the traffic lane
- Other On the sidewalk
- Not sure
- Other (please specify)

Bicycle Infrastructure Treatments

*** 4. If you encountered the situation pictured above in IMAGE 1 while on a bicycle, where would you ride? Assume the traffic is MODERATE to HEAVY and the speed limit is 45 MPH.**

- As far to the right as possible
- Towards the right, but about 3-5 feet away from parked cars
- In the middle of the traffic lane
- Other On the sidewalk
- Not sure
- Other (please specify)

Image 2

Other

*** 5. Have you ever seen a "bike lane" like the one pictured above in IMAGE 2?**

- YES, only while driving
- YES, only while riding a bike
- YES, both driving and riding
- NO

Image 3

* **1. If you encountered the situation pictured above in IMAGE 3 while on a bicycle, where would you ride? Assume the traffic is LIGHT to MODERATE and the speed limit is 25 MPH.**

- On the right side of the regular lane
- In the middle of the regular lane
- In the green lane
- On the sidewalk
- Not sure
- Other (please specify)

*** 2. If you encountered the situation pictured above in IMAGE 3 while on a bicycle, where would you ride? Assume the traffic is MODERATE to HEAVY and the speed limit is 25 MPH.**

- On the right side of the regular lane
- In the middle of the regular lane
- In the green lane
- On the sidewalk
- Not sure

Other

- Other (please specify)

*** 3. If you encountered the situation pictured above in IMAGE 3 while on a bicycle, where would you ride? Assume the traffic is LIGHT to MODERATE and the speed limit is 45 MPH.**

- On the right side of the regular lane
- In the middle of the regular lane
- In the green lane
- On the sidewalk
- Not sure

Other

- Other (please specify)

Bicycle Infrastructure Treatments

*** 4. If you encountered the situation pictured above in IMAGE 3 while on a bicycle, where would you ride? Assume the traffic is MODERATE to HEAVY and the speed limit is 45 MPH.**

- On the right side of the regular lane
- In the middle of the regular lane
- In the green lane
- On the sidewalk
- Not sure

Other

- Other (please specify)

*** 5. Have you ever seen a narrow green lane like the one pictured above in IMAGE 3?**

- YES, only while driving
- YES, only while riding a bike
- YES, both driving and riding
- NO

Image 4

*** 1. If you encountered the situation pictured above in IMAGE 4 while on a bicycle, where would you ride? Assume the traffic is LIGHT to MODERATE and the speed limit is 25 MPH.**

- On the right side of the regular lane
- In the middle of the regular lane
- In the green lane
- On the sidewalk
- Not sure
- Other (please specify)

*** 2. If you encountered the situation pictured above in IMAGE 4 while on a bicycle, where would you ride? Assume the traffic is MODERATE to HEAVY and the speed limit is 25 MPH.**

- On the right side of the regular lane
- In the middle of the regular lane
- In the green lane
- On the sidewalk
- Not sure

Other

- Other (please specify)

*** 3. If you encountered the situation pictured above in IMAGE 4 while on a bicycle, where would you ride? Assume the traffic is LIGHT to MODERATE and the speed limit is 45 MPH.**

- On the right side of the regular lane
- In the middle of the regular lane
- In the green lane
- On the sidewalk

Other

- Not sure
- Other (please specify)

*** 4. If you encountered the situation pictured above in IMAGE 4 while on a bicycle, where would you ride? Assume the traffic is MODERATE to HEAVY and the speed limit is 45 MPH.**

- On the right side of the regular lane
- In the middle of the regular lane
- In the green lane
- On the sidewalk
- Not sure
- Other (please specify)

Other

*** 5. Have you ever seen a green bike lane like the one pictured above in IMAGE 4?**

- YES, only while driving
- YES, only while riding a bike
- YES, both driving and riding
- NO

Other

Image 5

* **1. If you encountered the situation pictured above in IMAGE 5 while on a bicycle, where would you ride? Assume the traffic is LIGHT to MODERATE and the speed limit is 25 MPH.**

- As far to the right as possible
- In line with the white bike arrows
- In the middle of the traffic lane
- On the sidewalk
- Not sure
- Other (please specify)

Bicycle Infrastructure Treatments

*** 2. If you encountered the situation pictured above in IMAGE 5 while on a bicycle, where would you ride? Assume the traffic is MODERATE to HEAVY and the speed limit is 25 MPH.**

- As far to the right as possible
- In line with the white bike arrows
- In the middle of the traffic lane
- On the sidewalk
- Not sure
- Other (please specify)

*** 3. If you encountered the situation pictured above in IMAGE 5 while on a bicycle, where would you ride? Assume the traffic is LIGHT to MODERATE and the speed limit is 45 MPH.**

- As far to the right as possible
- In line with the white bike arrows
- In the middle of the traffic lane
- On the sidewalk
- Not sure
- Other (please specify)

Other

Bicycle Infrastructure Treatments

*** 4. If you encountered the situation pictured above in IMAGE 5 while on a bicycle, where would you ride? Assume the traffic is MODERATE to HEAVY and the speed limit is 45 MPH.**

- As far to the right as possible
- In line with the white bike arrows
- In the middle of the traffic lane
- On the sidewalk
- Not sure
- Other (please specify)

Other

*** 5. Have you ever seen a bike and arrows design before like the one pictured above in IMAGE 5?**

- YES, only while driving
- YES, only while riding a bike
- YES, both driving and riding
- NO

Image 6

*** 1. If you encountered the situation pictured above in IMAGE 6 while on a bicycle, where would you ride? Assume the traffic is LIGHT to MODERATE and the speed limit is 25 MPH.**

- As far to the right as possible
- In line with the white bike image

Other

- In the middle of the traffic lane
- On the sidewalk
- Not sure
- Other (please specify)

Bicycle Infrastructure Treatments

*** 2. If you encountered the situation pictured above in IMAGE 6 while on a bicycle, where would you ride? Assume the traffic is MODERATE to HEAVY and the speed limit is 25 MPH.**

- As far to the right as possible
- In line with the white bike image
- In the middle of the traffic lane
- On the sidewalk
- Not sure
- Other (please specify)

*** 3. If you encountered the situation pictured above in IMAGE 6 while on a bicycle, where would you ride? Assume the traffic is LIGHT to MODERATE and the speed limit is 45 MPH.**

- As far to the right as possible
- In line with the white bike image
- In the middle of the traffic lane
- On the sidewalk
- Not sure
- Other (please specify)

Bicycle Infrastructure Treatments

*** 4. If you encountered the situation pictured above in IMAGE 6 while on a bicycle, where would you ride? Assume the traffic is MODERATE to HEAVY and the speed limit is 45 MPH.**

- As far to the right as possible
- In line with the white bike image
- In the middle of the traffic lane
- On the sidewalk
- Not sure
- Other (please specify)

*** 5. Have you ever seen a bike and arrows design with dotted lines like the one pictured above in IMAGE 6?**

Other

- YES, only while driving
- YES, only while riding a bike
- YES, both driving and riding
- NO

Image 7

* **1. If you encountered the situation pictured above in IMAGE 7 while on a bicycle, where would you ride? Assume the traffic is LIGHT to MODERATE and the speed limit is 25 MPH.**

- As far to the right as possible
- In the green "lane"
- On the sidewalk
- Not sure

Other
- Other (please specify)

* **2. If you encountered the situation pictured above in IMAGE 7 while on a bicycle, where would you ride? Assume the traffic is MODERATE to HEAVY and the speed limit is 25 MPH.**

- As far to the right as possible
- In the green "lane"
- On the sidewalk
- Not sure
- Other (please specify)

Other

*** 3. If you encountered the situation pictured above in IMAGE 7 while on a bicycle, where would you ride? Assume the traffic is LIGHT to MODERATE and the speed limit is 45 MPH.**

- As far to the right as possible
- In the green "lane"
- On the sidewalk
- Not sure
- Other (please specify)

*** 4. If you encountered the situation pictured above in IMAGE 7 while on a bicycle, where would you ride? Assume the traffic is MODERATE to HEAVY and the speed limit is 45 MPH.**

- As far to the right as possible
- In the green "lane"
- On the sidewalk
- Not sure
- Other (please specify)

*** 5. Have you ever seen a green lane in the middle of a traffic lane like the one pictured above in IMAGE 7?**

- YES, only while driving
- YES, only while riding a bike
- YES, both driving and riding
- NO

Image 8

Bicycle Infrastructure Treatments

*** 1. If you encountered the situation pictured above (with the "Share the Road" sign placed by the roadway) while on a bicycle, where would you ride? Assume the traffic is LIGHT to MODERATE and the speed limit is 25 MPH.**

- As far to the right as possible
- Towards the right, but about 3-5 feet away from parked cars
- In the middle of the traffic lane
- On the sidewalk
- Not sure
- Other (please specify)

*** 2. If you encountered the situation pictured above (with the "Share the Road" sign placed by the roadway) while on a bicycle, where would you ride? Assume the traffic is MODERATE to HEAVY and the speed limit is 25 MPH.**

- As far to the right as possible
- Towards the right, but about 3-5 feet away from parked cars
- In the middle of the traffic lane
- On the sidewalk
- Not sure
- Other (please specify)

*** 3. If you encountered the situation pictured above (with the "Share the Road" sign placed by the roadway) while on a bicycle, where would you ride? Assume the traffic is LIGHT to MODERATE and the speed limit is 45 MPH.**

- As far to the right as possible
- Towards the right, but about 3-5 feet away from parked cars
- In the middle of the traffic lane
- On the sidewalk
- Not sure
- Other (please specify)

*** 4. If you encountered the situation pictured above (with the "Share the Road" sign placed by the roadway) while on a bicycle, where would you ride? Assume the traffic is MODERATE to HEAVY and the speed limit is 45 MPH.**

- As far to the right as possible
- Towards the right, but about 3-5 feet away from parked cars
- In the middle of the traffic lane
- On the sidewalk
- Not sure
- Other (please specify)

*** 5. Have you ever seen a "SHARE THE ROAD" sign like the one pictured above in IMAGE 8?**

- YES, only while driving
- YES, only while riding a bike
- YES, both driving and riding
- NO

Image 9

Bicycle Infrastructure Treatments

*** 1. If you encountered the situation pictured above (with the "Bikes May Use Full Lane" sign placed by the roadway) while on a bicycle, where would you ride? Assume the traffic is LIGHT to MODERATE and the speed limit is 25 MPH.**

- As far to the right as possible
- Towards the right, but about 3-5 feet away from parked cars
- In the middle of the traffic lane
- On the sidewalk
- Not sure
- Other (please specify)

*** 2. If you encountered the situation pictured above (with the "Bikes May Use Full Lane" sign placed by the roadway) while on a bicycle, where would you ride? Assume the traffic is MODERATE to HEAVY and the speed limit is 25 MPH.**

- As far to the right as possible
- Towards the right, but about 3-5 feet away from parked cars
- In the middle of the traffic lane
- On the sidewalk
- Not sure
- Other (please specify)

*** 3. If you encountered the situation pictured above (with the "Bikes May Use Full Lane" sign placed by the roadway) while on a bicycle, where would you ride? Assume the traffic is LIGHT to MODERATE and the speed limit is 45 MPH.**

- As far to the right as possible
- Towards the right, but about 3-5 feet away from parked cars
- In the middle of the traffic lane
- On the sidewalk
- Not sure
- Other (please specify)

*** 4. If you encountered the situation pictured above (with the "Bikes May Use Full Lane" sign placed by the roadway) while on a bicycle, where would you ride? Assume the traffic is MODERATE to HEAVY and the speed limit is 45 MPH.**

- As far to the right as possible
- Towards the right, but about 3-5 feet away from parked cars
- In the middle of the traffic lane
- On the sidewalk
- Not sure
- Other (please specify)

*** 5. Have you ever seen a "BICYCLES MAY USE FULL LANE" sign like the one pictured above in IMAGE 9?**

- YES, only while driving
- YES, only while riding a bike
- YES, both driving and riding
- NO

Image 10 (courtesy of Flickr, itdp)

*** 1. If you encountered the situation pictured above in IMAGE 10 while on a bicycle, where would you stop and wait during a red-light? Assume the bike lane continues on the other side of the intersection.**

- Section A
- Section B
- Section C
- Section D
- Section E

*** 2. If you encountered the situation pictured above in IMAGE 10 while on a bicycle, where would you stop and wait during a red-light? Assume the bike lane DOES NOT continue on the other side of the intersection.**

- Section A
- Section B
- Section C
- Section D
- Section E

Bicycle Infrastructure Treatments

*** 3. Have you ever seen a "bike box" before like the one pictured?**

- YES, but only while driving
- YES, only while riding a bike
- YES, both while driving and riding
- NO

Bicycle Infrastructure Treatments

The intent of this page is to define the purpose of the treatments you saw in the previous sections, and educate you as to how a bicyclist should use each.

Please read each description on the few pages that follow carefully, as a few more questions will be asked about each treatment once you understand their purpose.

Green Bike Lane: This is the same as a "regular" bike lane, but is painted green to make motorists more aware of bicycles in the lane. Bicyclists should ride in the lane when available. These lanes may or may not have the white bicycle markings on them. The green paint provides the same friction as asphalt when wet (i.e. it is not more slippery when wet than asphalt).

1. Do you have any comments about the green bike lane?

Bicycle Infrastructure Treatments

The intent of this page is to define the purpose of the treatments you saw in the previous sections, and educate you as to how a bicyclist should use each.

Sharrow: The white bicycle and two arrows design is called a "Sharrow", meaning "shared lane arrow". Cyclists should ride in line with the emblem. It is placed to prevent riding any further to the right, which endangers bicycles with being hit by an opening door from an adjacent parked vehicle. Riding any further to the left can slow and/or block traffic. Its purpose is to give bicycles a space to confidently ride between the "dooring-zone" of parked cars and the travel lane to allow vehicles to pass safely without changing lanes. It is also intended to make motorists aware of potential bicycles.

1. Do you have any comments about the Sharrow?

Sharrow Bicycle Priority Lane: This treatment is a combination of the "sharrow" and dotted lines around it to give both cyclists and motorists the perception of a bike lane. It is NOT a typical bike lane, however, as it is still in the travel lane for vehicles. Cyclists should ride in the middle of this emblem, and motorists are to yield to bicycles. Its purpose is to give bicyclists a space to confidently ride outside of the "dooring-zone" of parked vehicles while also making motorists more aware of potential bicycles.

2. Do you have any comments about the Sharrow Bicycle Priority Lane?

Green Bicycle Priority Lane: This treatment is the same as the sharrow priority lane above, except it's painted green for visibility. Bicycles should ride in the middle of the green lane, and motorists are to yield to bicycles. Its purpose is to give bicycles a space to confidently ride outside of the "dooring-zone" of parked vehicles while also making motorists more aware of potential bicycles.

3. Do you have any comments about the Green Bicycle Priority Lane?

"SHARE THE ROAD" sign: This sign is spaced evenly along a roadway. Its purpose is to alert motorists to the presence of bicycles and urge them to share the road.

4. Do you have any comments about the "SHARE THE ROAD" sign?

BIKES "MAY USE FULL LANE" sign: This sign is spaced evenly along a roadway. Its intent is to inform bicycles they are entitled to ride in the center of the traffic lane and that motorists are to yield to bicycles.

5. Do you have any comments about the "BIKES MAY USE FULL LANE" sign?

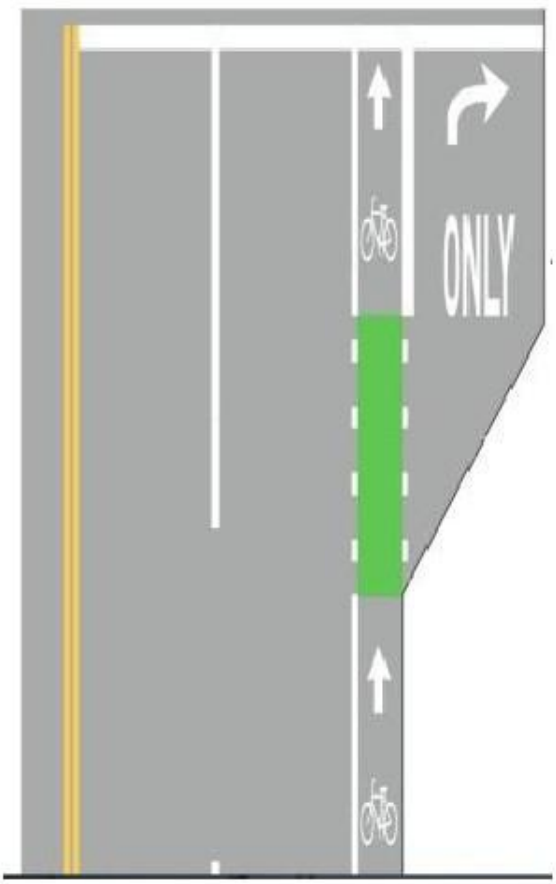
Bicycle Infrastructure Treatments

The intent of this page is to define the purpose of the treatments you saw in the previous sections, and educate you as to how a bicyclist should use each.

Bike Box: This treatment is utilized at signalized intersections. Its purpose is to increase motorists' visibility of bicycles by putting bicycles in front of vehicles while stopped rather than besides one another. Motorists are to stop behind the white bar that says "WAIT HERE", and bicycles are to stop in the green box in front of this white line, in Section C or Section D. This enables bicycles to skip a queue of vehicles and stop in front of the stopped vehicles on a red light.

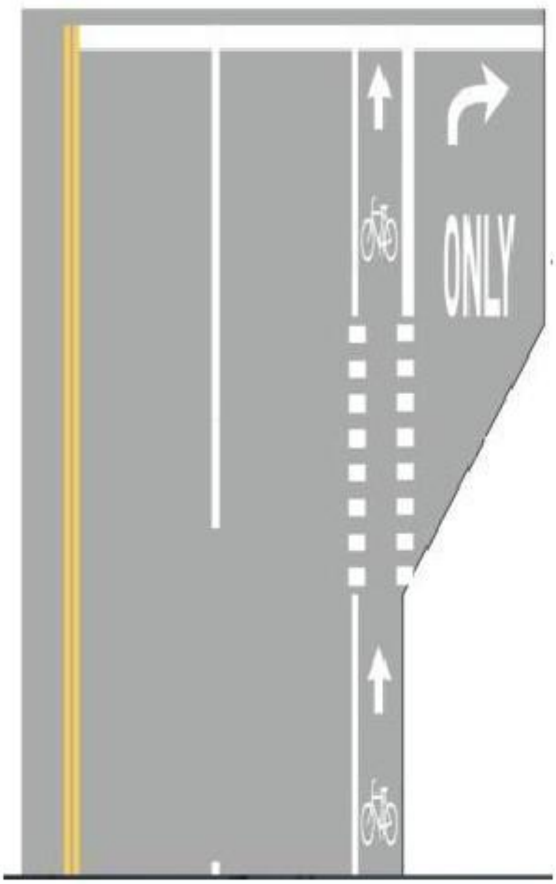
1. Do you have any comments about the "Bike Box"?

Green Bike Lane in Conflict Areas: This treatment involves painting green the portion of a bike lane that crosses a traffic lane in high-conflict areas. This often happens at on- and off-ramps, through intersections, and at turning lanes. Motorists should always yield to bicycles when crossing a bicycle lane. Its purpose is to improve motorist visibility and expectancy of bicycles, while giving bicycles confidence that they have been seen by motorists.



2. Do you have any comments about the green bike lanes in conflict areas?

"Elephant Footprint" Markings: These large squares that dot the bicycle lane are called "elephant footprints". They are used in the same high-conflict areas as the green section of bike lanes mentioned above. Its purpose is to improve motorist visibility and expectancy of bicycles, while giving bicycles confidence that they have been seen by motorists.



3. Do you have any comments about the "Elephant Footprint" markings?

Bicycle Infrastructure Treatments

Please use the pictures below to answer the question that follows.

Green Bicycle Priority Lane

Sharrow Bicycle Priority Lane

Bicycle Infrastructure Treatments

Sharrows

*** 1. It situations where any type of bike-specific lane is NOT present, please rate the following lane-treatments from most preferred (5) to least preferred (1) if you are riding a bicycle:**

	5 - Most Preferred	4	3	2	1 - Least Preferred
Green bicycle priority lane					
"Share the Road" sign					
Sharrow bicycle priority lane					
"Bicycles May Use Full Lane" sign					
Sharrows					

Bicycle Infrastructure Treatments

Please use the images below to answer the following question.

Green Bicycle Lane - with markings

Green Bicycle Lane - without markings

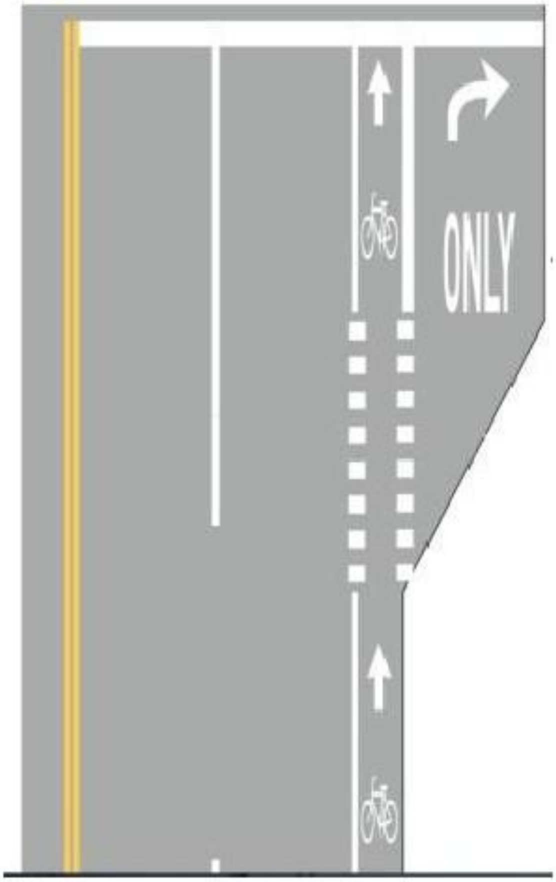
Standard Bicycle Lane

* **1. In situations where bike-specific lanes are present, please rate the following facility in order of most preferred (3) to least preferred (1) if you are riding a bicycle.**

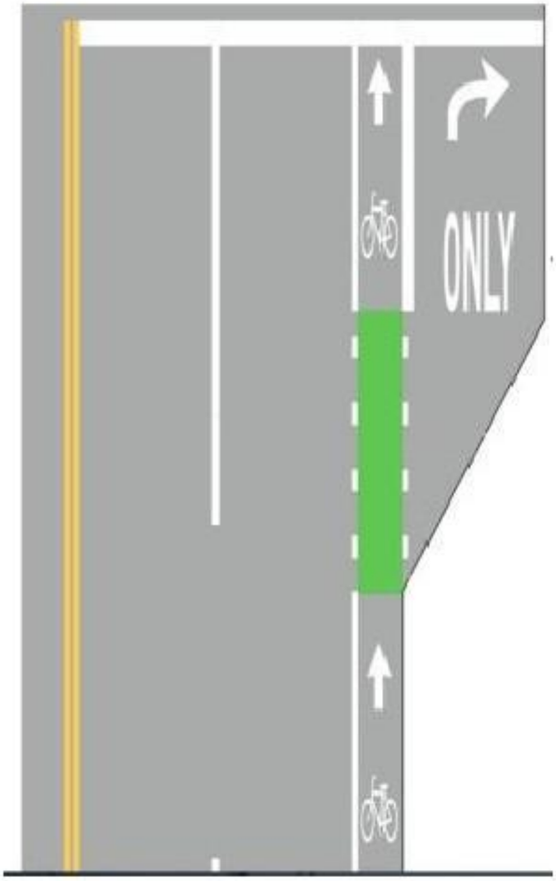
	3 - Most Preferred	2	1 - Least Preferred
Green bicycle lane, with markings			
Standard bicycle lane			
Green bicycle lane, without markings			

Please use the images below to answer the following question.

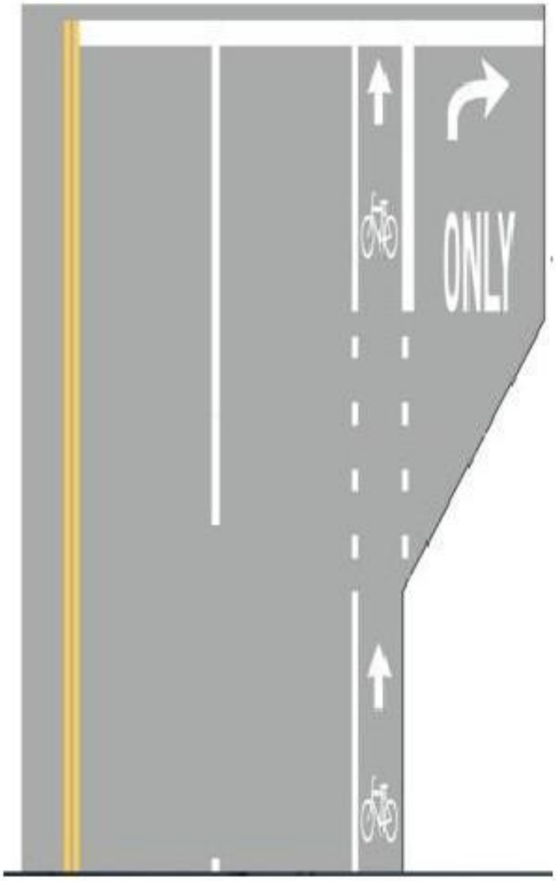
"Elephant Footprint" Markings



Green Painted Lane



Dashed Bike Lane



* **1. In situations where a type of bike lane crosses another lane of traffic (i.e. at an on - ramp or off-ramp, through an intersection, at a turn lane, etc.) please rate the following treatments in order of most preferred (4) to least preferred (1) if you are riding a bicycle:**

	4 - Most Preferred	3	2	1 - Least Preferred
Dashed bike lane lines				
No special treatment				
"Elephant Footprint" markings				
Green painted lane				

Thank you for your time! You have helped provide valuable research about new bicycle treatments to help improve bicycle safety on our roadways!

1. Please enter your email address to be entered into the random drawing for the $100 gift card to REI! (your email address will not be used or sold for any other purpose)

Email Address:

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