

Report on Human Factors Comparison
On Perceived Meaning of Three Alternative
Shared Use Symbols

Submitted to
The City of San Francisco

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Introduction

The use of a shared use pavement marking has four goals. First, it can increase the percentage of bicyclists riding in the street, which can reduce the percentage of crashes with turning vehicles. Second, it can increase the percentage of bicyclists riding with traffic, which can also reduce the frequency of crashes with turning vehicles. Third, it can influence placement of the bicycle within the lane. Positioning the bicyclist with the lane can reduce the threat of a crash into an opening door of a parked vehicle, reduce the threat of crashes with right turning vehicles by improving the visibility of bicycles to drivers initiating a right turn, and reduce the incidence of motorists passing too close to the bicyclist by encouraging bicyclists to take the lane when there is not sufficient lane width for the bicycle and motorists to safely share the lane. Fourth, it can alert motorists that bicycles should be expected along the route.

The purpose of this study was to compare driver and bicyclist comprehension of three alternative designs for the shared use arrow being considered for evaluation by the City of San Francisco. One version of the shared use pavement marking has been evaluated by the Florida Department of Transportation (Florida Department of Transportation Pedestrian/Bicycle Safety Section, 1999). In that study a bike symbol embedded within an arrow was used to designate a shared use facility. Behavioral data indicated that the arrow significantly increased the percentage of bicyclists riding in the street from 39% to 45%, reduced wrong way bicycling from 10.1% to 6.4%, and increased the distance bicycles rode from the curb by 3 inches. Although these differences were statistically significant, the magnitude of the effects was not particularly large. However any tool that can reduce wrong way bicycling and reduce the percentage of bicyclists riding on the sidewalk has the potential for improving

safety. However, it would be desirable to enhance the effects of the marking, particularly in moving more bicyclists into the street as well as moving them further from the danger of opening car doors.

Method

Sample Size. A sample size of 120 bicyclists and 120 motorists were each randomly divided into three groups of 40. Randomization was achieved by handing out the sheets to bicyclists or motorists as they arrived at survey points within blocks of three randomly ordered sequences. A power analysis indicated that a difference of 10% could be detected at the 5% confidence level with a sample of 40 in each cell. To detect a 5% difference the sample size would have to be increased to 480 motorists and 480 bicyclists, which was beyond the budget available for this study and the ability to detect differences of 10% was judged to be adequate to determine the relative efficacy of the three markings.

General Procedure. Bicycle and driving commuters were each sampled as they arrived at work at a number of large employment locations. Each participant first received the following general directions: "I am going to give you a photograph showing you the what you would see in front of you if you were (driving/cycling) on a particular road and then I will ask you a series of questions. Please try to answer each question. However, if after considering the question, you can't think of an answer or don't understand the question you may respond by saying you don't know. You may provide more than one answer to each question if think more than one answer is appropriate." They were further informed that the research assistant could not help them or clarify the question in any way. The interviewer then gave the participant an 8¹/₂ by 11 inch photograph, asked the questions and recorded the participant's responses verbatim. The photographs of each of the arrows are shown in Figure 1.

Instructions Given to Motorists. Motorists were asked to imagine they were driving down the street shown in the photograph. They were first asked the open-ended question, "What should you do?" This question did not attempt to focus their attention on the shared use marking and was included to determine how easily it attracted their attention. If they provided an answer they were then asked "Why?" Next they were asked what the symbol on the roadway meant. This question was followed by the question "What should you do when you see this symbol?"

Instructions Given to Bicyclists. Cyclists were asked to imagine they were riding a bicycle down the street shown in the photograph. This picture shows what you see in front of you." Participants were first asked the open-ended question "What should you do?" This question did not attempt to focus their attention on the shared use marking and was included to determine how easily it attracted their attention. If they provided a response to question 1 they were asked "Why?" Next they were asked what the symbol on the roadway meant. This question was followed by the question "What should you do when you see this symbol?" The final question enquired where they should ride. All responses were categorized and then entered into a spreadsheet for analysis.

Statistical Analysis. All comparisons were calculated with the Fisher exact test. Two sided tests were used in all but those contrasts where a specific prediction was made. Specifically a prediction was made the arrow alone would influence more motorists and bicyclists to erroneously conclude that they could not turn at the intersection.

Results

Motorists Responses. When motorists were shown a picture and asked what they should do if they were driving down the road and confronted with one of the three roadway images, about half indicated that they should stay in the left lane. However, there were no significant differences in the probability of motorist making this response when presented with the three markings. The next most common response was to watch for cyclists, which averaged between 30 and 32%. None of these differences were found to be significant. The next most common responses to this question were to drive straight ahead or to slow down, with respective averages of 16% and 14%. Again, no significant differences were detected.

When asked why they should do this, the most common response was because it is a bike lane with 30% for the bike in the arrow symbol, 53% for the bike and separate arrow symbol and 40% for the bike and chevron marking. On average 13% said they should do so for safety reasons. It is interesting that overall many of motorists thought it was a bike lane.

When directly asked what the symbol meant, significantly more of the respondents (52%) who were shown the separate bike and arrow marking thought it indicated a bike lane while only 30% shown the bike in the arrow marking thought it indicated a bike lane. However 32% of those shown the bike inside the arrow marking thought it indicated a bike lane ahead, compared with 10% for the bike with a separate arrow and 27.5% for the bike and chevrons markings. When the number who thought it was a bike lane and those who thought it signified a bike lane ahead were summed about two thirds of the respondents who evaluated any of the three markings thought the markings meant bike lane or bike lane ahead.

When asked what they should do when they see the symbol, the most common responses were Watch for cyclists, Move or stay in left lane, watch for cyclists and slow down. Each of these responses indicated that the symbol increased bicycle awareness. Because participants could make more than one response, the percentage of participants who made any of the above mentioned responses was calculated and averaged 88% for the bike inside arrow, 100% for the bike and separate arrow and 98% for the bike and chevron markings. The only contrast that approached significance was that more motorists responded that they should slow down to the bike and chevrons marking more often than they did to the bike inside arrow marking ($p=0.07$).

Bicyclists Response. When bicyclists were asked what they should do if they were riding down the road and confronted with one of the three roadway images the most common responses were Stay in the right lane, follow the arrow and be observant. The only difference that approached significance was that more people responded that they should be observant to the bike inside the arrow marking than to the bike and separate arrow marking ($p=0.07$). When asked why they should do this, the most common responses were because the symbol indicates they should, and safety reasons.

A very important finding was that significantly more people incorrectly thought the Bike and separate arrow was a straight only lane ($p= 0.05$) although the percentage was small (13%). It should be noted however that none of the respondents thought the bike inside an arrow or bike and chevron markings indicated that they had to bike straight ahead.

When asked what the symbol meant, the most common response was bike lane or bike lane ahead. One important result was that significantly more people thought the bike and separate arrow marking represented a bike lane

than bike and chevrons markings ($p= 0.02$). The next most common response was ride straight ahead. Another interesting finding was that more people interpreted the bike and chevron marking as indicating, “share the road” (23%) than the bike and separate arrow marking (8%), and the bike inside the arrow marking (10%).

The most common response to the question what should you do when you see this marking was ride in the symbol lane with two thirds of bicyclists surveyed making this response. Significantly more people responded bike straight only to the bike and separate arrow marking ($p= 0.03$) then to the bike inside the arrow or bike and chevrons markings ($p= 0.03$). In addition significantly more people responded bike straight to the bike inside the arrow symbol than to the bike and Chevrons markings ($p= 0.05$).

The last question asked respondents where they should ride. There were no significant differences between the symbols. The Bike inside the arrow marking elicited the response bike over the symbol from 38% of the respondents compared with 35% for the bike and separate arrow marking, and 28% for the bike and chevron marking. The next most frequently provided response was anywhere in the lane with 28%, 30%, and 28% respectively responding this response.

Discussion

The results of the survey of motorists indicated that all three markings encourage motorists to be more aware of bicycles. When directly asked the meaning of the symbols, about two thirds of the motorists thought that all three symbols either indicated a bike lane or a bike lane ahead. When asked how they should respond to the symbols most of the motorists responded with at least

one response that indicated that they should exhibit caution because of the presence of bicyclists. Overall, the three markings were effective at conveying the message of bicycle awareness. The bike and chevron marking was more likely to elicit the response slow down than the bike inside the arrow symbol.

The results of the survey of bicyclists indicated that about half of the participants thought they should stay in the right lane and follow the arrow when they saw the pictures of the roadways with each of the installed markings. The only significant difference was that more people responded that they should be observant to the bike inside the arrow marking than the bike and separate arrow marking. One important finding was that the bike with separate arrow markings was significantly more likely to convey the incorrect message only bike straight ahead at the intersection ahead. None of the cyclists responded this way to the bike inside the arrow or bike and chevron markings. Therefore, the bike and separate arrow is not recommended. The arrow alone marking has a specific meaning, no turns permitted, this makes it more likely that motorists and cyclists would mistake this marking for a right turn prohibition. For this reason it is highly unlikely that National Committee on Uniform Traffic Control Devices (NCUTCD) would ever approve this marking.

When asked what the symbol meant about two thirds of the cyclists thought all markings either indicated a bike lane or else a bike lane ahead. Significantly more respondents thought the bike and chevron marking indicated a shared use lane than the bike and separate arrow marking. This is an important finding because promoting the shared use message is an important purpose of the markings. When asked what they should do when they see the marking, significantly more of the cyclists who responded to the Bike and Chevron markings thought they should ride in the symbol lane (78%) than either the Bike

inside arrow marking (63%) or Bike and separate arrow marking (60%). In addition fewer respondents thought they should bike straight ahead (but not only straight) when viewing the Bike and Chevron (8%) than the Bike inside the Arrow (25%) or Bike and Separate Arrow markings (18%).

When asked where they should ride, 38% of respondents who looked at the Bike in Arrow marking responded over the marking, 35% of the people who looked at the Bike and Separate Arrow responded over the arrow, and 28% of the respondents who looked at the Bike and Chevron marking responded over the marking. These differences were not statistically significant. However, the bike and chevron marking seems work less well at conveying this message. Because none of the symbols induced even half of the respondents to say they should ride over the markings, it is recommended that this treatment be accompanied by an outreach and awareness campaign to explain the meaning of the markings, as well as what the bicyclist's response to the markings ought to be.

One way to educate bicyclists is to pair the symbol with text messages at some sites. One message which might enhance the understanding of the symbol are "BICYCLISTS RIDE OVER ARROW", others would be "SHARED USE LANE" and "BIKE WITH TRAFFIC". These messages reinforce the main purposes of using the markings, which are to increase bicycle awareness among drivers, to influence bicyclist placement on the road, and to deter wrong way bicycling. By the time these supplementary messages have worn away, it is likely that the community will understand the symbol. All three arrows do a fair job of conveying the bicycle awareness message but do not have nearly as strong effect conveying the rider placement message. This may be why the FDOT study produced such poor results. Another way to improve rider

placement might be to include a short stretch of temporary (painted) marking that shows a bicycle tread. It is possible that the tread marking would serve as a better position cue. If the goal is to get cyclists to ride outside the area where they can collide with opening car doors or to get them to take the lane when the lane is too narrow for a motorists to safely pass all three symbols well need support.

Recommendations

The following recommendations are offered to inform discussion on the selection of the most appropriate “shared use” marking.

1. The bike with separate arrow should be rejected because the arrow marking is already used to prohibit turns. Some evidence suggests that this marking conveyed this response to more cyclists than the other two messages. It is very unlikely that the NCUTCD would approve this marking because it would give one symbol two distinct conflicting meanings in the manual.
2. Because the Bike and Chevron marking seems to be marginally more effective than the Bike inside the Arrow marking it could be selected for evaluation in San Francisco. However, because one study showed a safety benefit of the Bike inside the Arrow markings, a second study using the same marking would more easily facilitate National adoption of this symbol. It should be noted however that more respondents judged the Bike and Chevron marking to indicate shared use.
3. Because none of the symbols induced even half of the respondents to say they should ride over the markings, it is recommended that this treatment be accompanied by an outreach and awareness campaign to explain the meaning of the markings, as well as what the bicyclist response to the markings ought to be. One message, which could be stenciled into the lane just after the marking is “BICYCLISTS RIDE OVER ARROW” if the bike inside arrow symbol is used or “BICYCLISTS RIDE OVER CHEVRON” if the bike and chevron marking is used. Alternatively a bicycle tread marking could be painted just before the symbol that is aligned with the point of the arrow or the points of the Chevrons. The

tread markings may prove an intuitive way to communicate this message and it is strongly recommended that it be evaluated at several of the sites to determine if it should be included as part of the marking.

Figure 1
Bike in Arrow Photograph



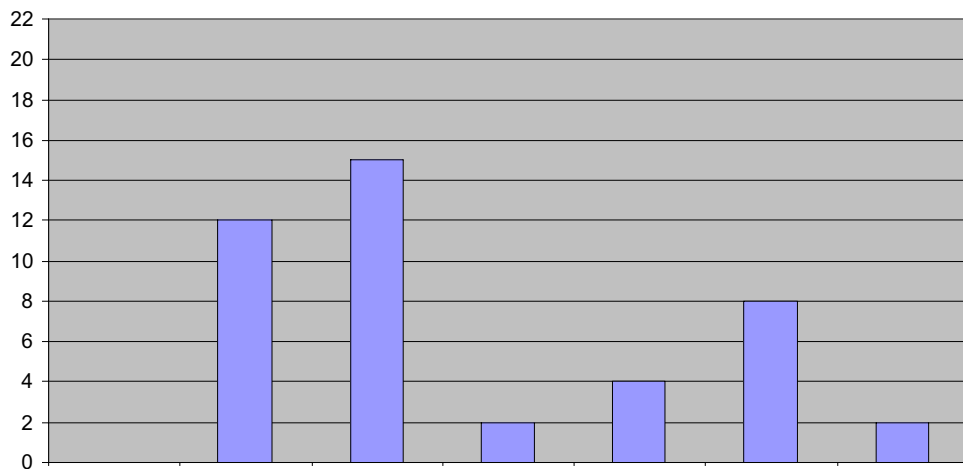
Bike and Separate Arrow Photograph



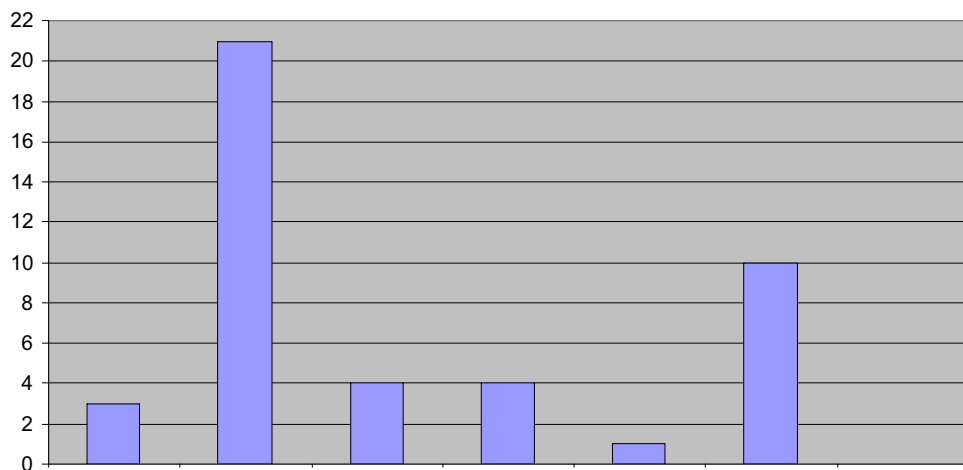
Bike and Chevrons Photograph



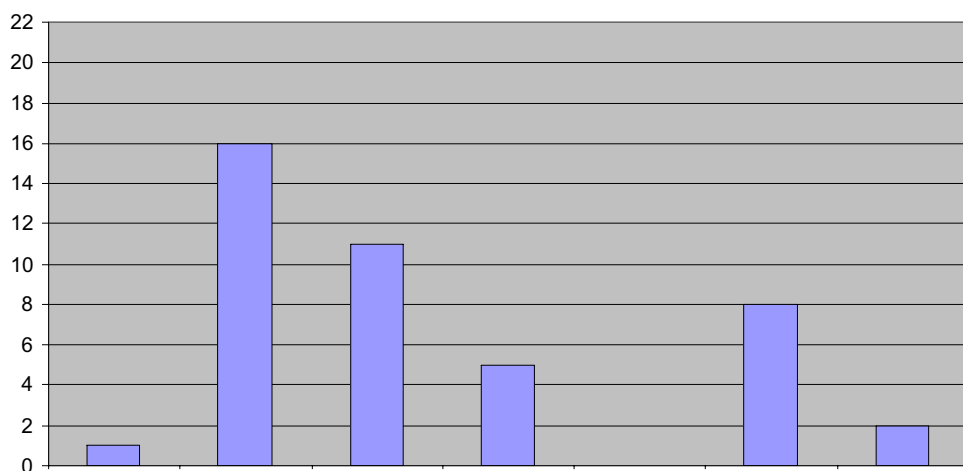
Figure 2a. Motorist's responses to "What does the marking mean?"



Bike in Arrow



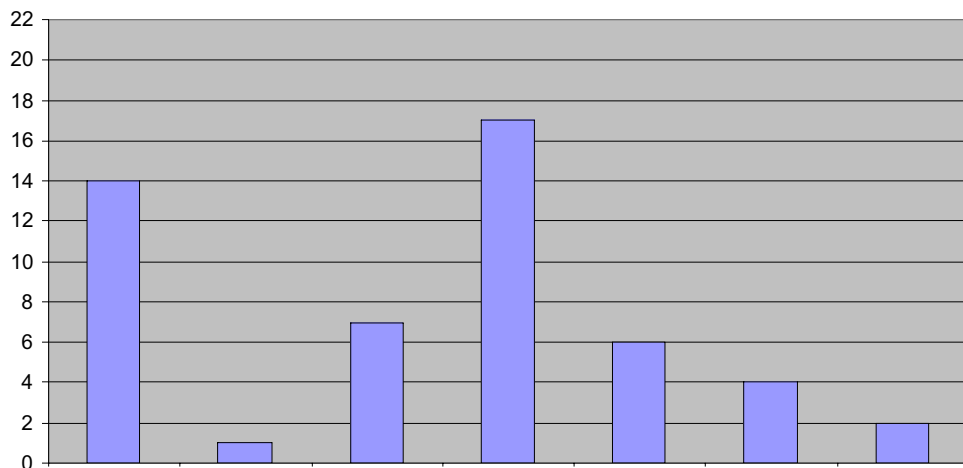
Bike and Arrow



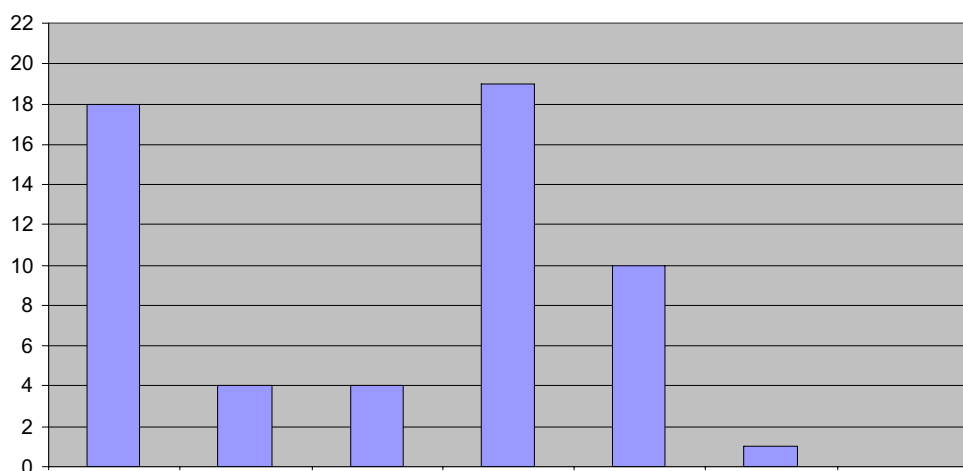
Bike and Chevrons

Shared use lane Bike lane Bike lane ahead Cyclists crossing ahead Drive straight only Beware of cyclists Don't know

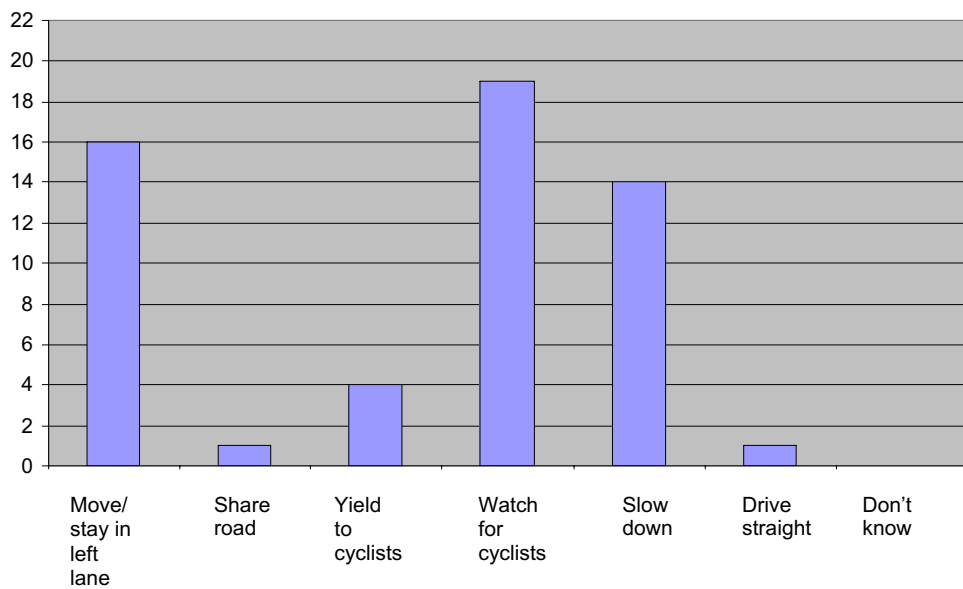
Figure 2b. Motorist's responses to "What should you do when you see this symbol?"



Bike in Arrow

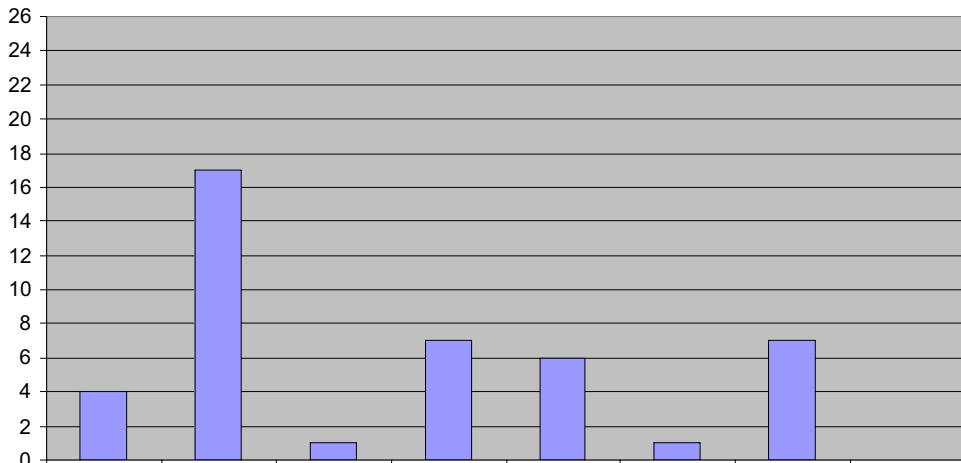


Bike and Arrow

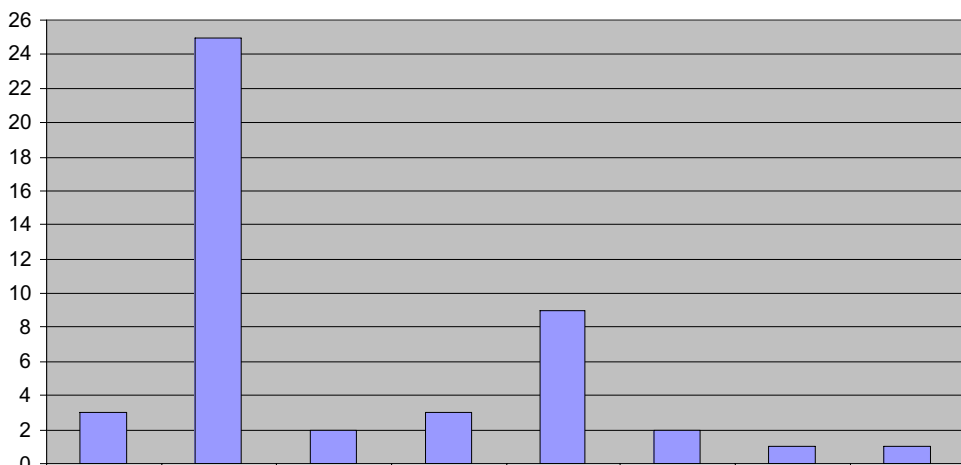


Bike and Chevrons

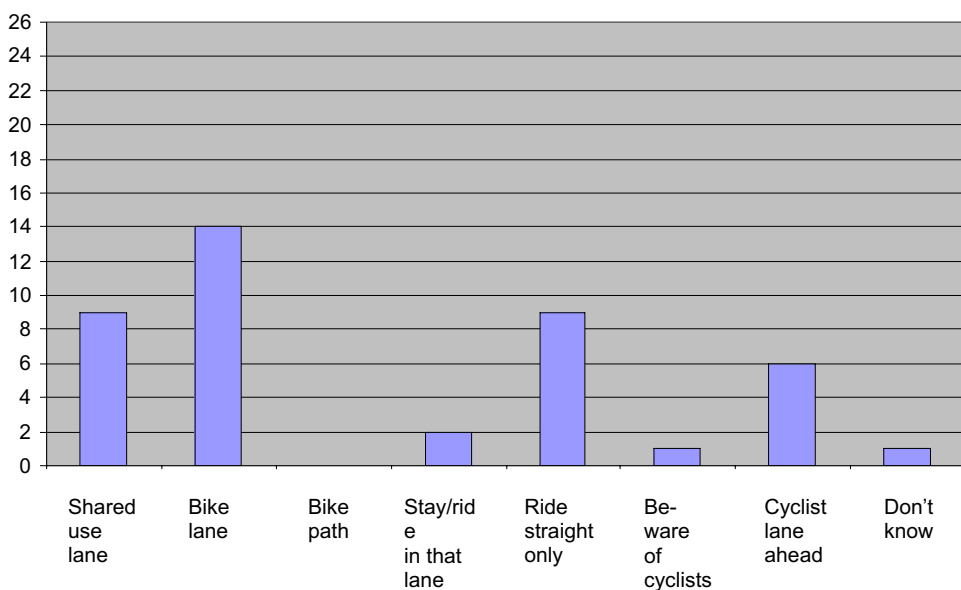
Figures 3a. Cyclist's responses to "What Does the marking mean?"



Bike in Arrow

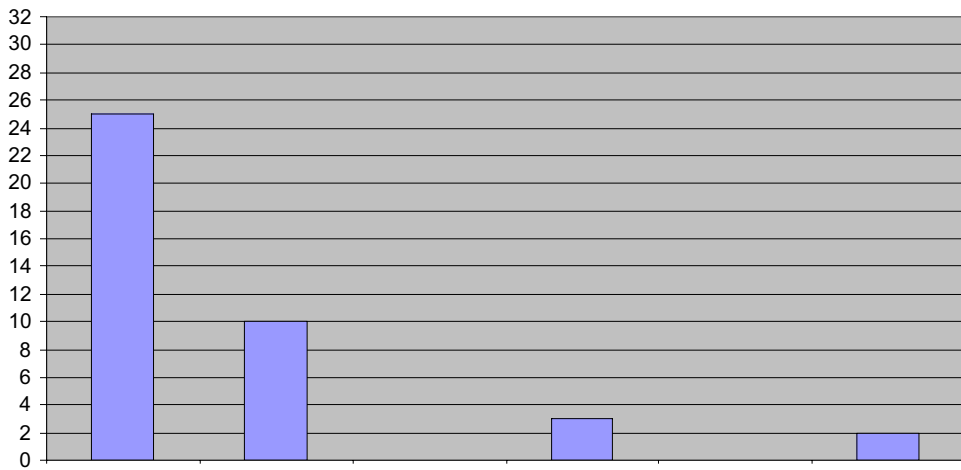


Bike and Arrow

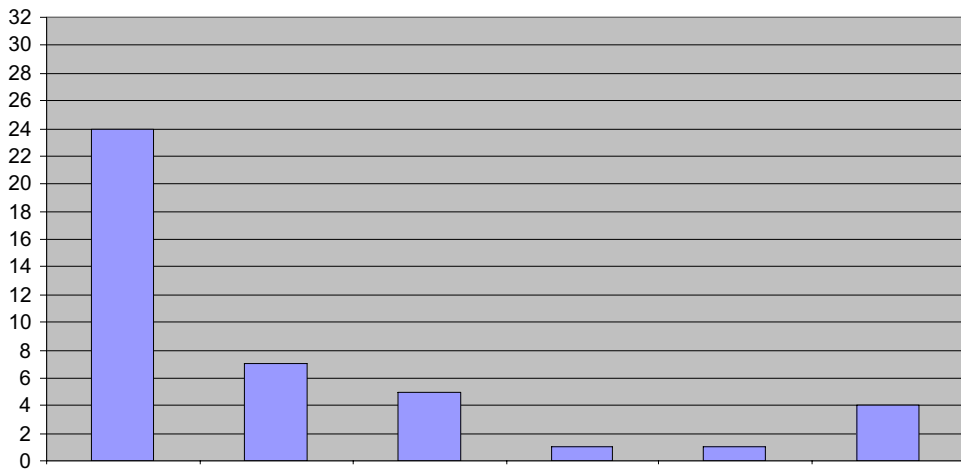


Bike and Chevron

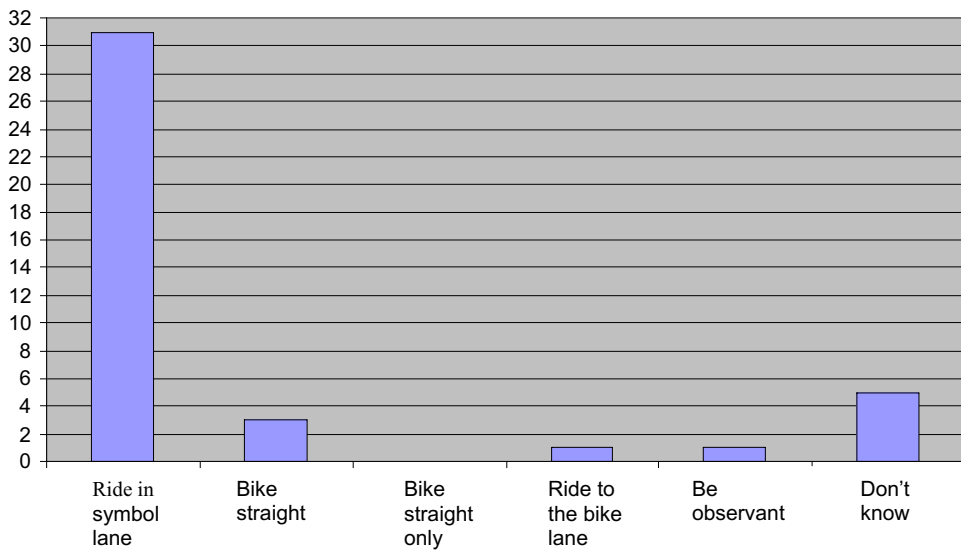
Figure 3b. Cyclist's responses to "What should you do when you see this marking?"



Bike in Arrow



Bike and Arrow



Bike and Chevrons