Driver Understanding of Protected and Permitted Left-Turn Signal Displays

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Driver comprehension of protected and permitted left-turn (PPLT) signal designs was evaluated by conducting a survey of 1,610 drivers. The survey included a perspective view of an intersection approach and its traffic signal display, followed by multiple-choice questions about the correct driving action. The survey questions were focused on four display indications in six different PPLT designs. The display indications included (*a*) permitted left-turn, (*b*) protected left-turn only, (*c*) overlapped left-turn and through, and (*d*) a modified form of the protected left-turn only indication. The modified indication deviates from the *Manual on Uniform Traffic Control Devices* guidelines for PPLT heads (which require both a green arrow and red ball) by displaying only the green arrow during the protected indication. The six PPLT designs varied in terms of the location of the signal head with respect to the lane line, the arrangement of the lenses in the signal head, and the inclusion of an auxiliary sign. The survey results indicate that drivers are better able to understand PPLT designs with any of the following characteristics: a modified protected indication, the PPLT head centered over the opposing left-turn lane, and no auxiliary sign.

The *Manual on Uniform Traffic Control Devices* (MUTCD) (*1*) provides considerable latitude in the design of traffic signals on intersection approaches with protected and permitted left-turn (PPLT) control. It identifies several different combinations of left-turn and through movement signal lens arrangements or displays that can be used, some general guidelines for locating signal heads, and several choices in auxiliary signing messages. As a result of this latitude, a wide variety of traffic signal designs with PPLT displays is in current use. In this paper, the combination of PPLT and through movement displays, auxiliary signing, and display location with respect to the lane lines on an intersection approach will be referred to as a "PPLT traffic signal design."

The diversity of PPLT traffic signal designs may confuse drivers as they travel in various cities throughout a state and may lead to unsafe and inefficient operations. In fact, a recent survey of traffic engineers conducted by the Florida Section of ITE (*2*) indicated that many drivers do not understand or trust the protected portion of the phase and may hesitate when the green arrow is displayed.

The objective of this research was to determine if some PPLT signal designs cause more confusion and operational and safety problems for drivers than others. This objective was accomplished by conducting studies of driver behavior, understanding, and accident history. The research described in this paper focuses on a survey of driver understanding of PPLT designs. Findings from the studies of driver behavior and accident history are described in the final project report (*3*).

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COMMON DESIGN CONSIDERATIONS AND CONFIGURATIONS

Design Decisions

When designing the PPLT and through movement traffic signal arrangement, the traffic engineer is faced with several questions, including the following:

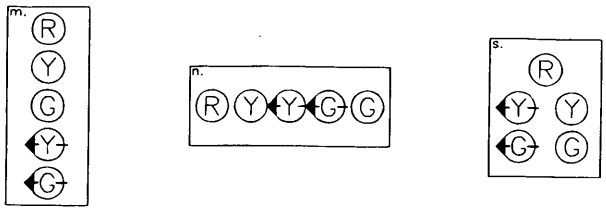
- What signal head arrangement should be used?
- Will the head be exclusive to one movement or shared by two or more movements?
- How far will the left-turn head be laterally offset from the lane lines and from the through signal heads?
- Is there a need for permanent or temporary auxiliary signing to better convey the meaning of the green ball to drivers making left turns?

These questions will be more fully examined in the following paragraphs. In all cases, it is assumed that an exclusive left-turn bay is provided for the PPLT movement.

Signal Head Lens Arrangements

In general, three PPLT signal head lens arrangements are being used in Nebraska. All three displays, shown in Figure 1, have five lenses arranged in a vertical, horizontal, or cluster pattern. The vertical display (MUTCD letter "m") has the advantage of being mountable on either mast arm or span wire and the disadvantage of being so tall that it requires a relatively high mounting to provide the minimum roadway clearance, unless it is mounted on or over a raised median.

The horizontal display ("n") has the advantages of being least sensitive to wind forces and requiring a minimum pole height to obtain the necessary roadway clearance. Its disadvantages are that it is unstable under moderate breezes when mounted on span wire, and that its lens arrangement may be confusing to some drivers. This latter disadvantage surfaces during the protected left-turn phase. During this phase, the green arrow is lit for the left-turn driver indicating that the left turn is protected; however, the red indication also remains lit because it is controlled by the coincident through phase (as required by MUTCD). In operation, this somewhat contradictory message rarely confuses motorists unless a horizontal display is used. In a horizontal display, the left-turn arrow is located to the right of the red ball and, during the protected left-turn phase, it points directly at the red ball. This orientation tends to amplify the contradiction of a green and red lens being lit at the same time and tends to confuse some motorists. In fact, a recent survey by Williams et al. (*4*) found that drivers were better able to interpret the intent of the



Vertical Display **Horizontal Display** **Cluster Display**

FIGURE 1 Protected/permitted left-turn signal displays (*1*).

green arrow when the red ball indication was off. Williams et al. recommended that a red ball and a green arrow should not be displayed simultaneously in a horizontal PPLT head.

The cluster display (MUTCD "s") has the advantage of being mountable on either span wire or mast arms. When the cluster head is used to control both through and left-turn movements in a shared arrangement, it has the additional advantage of displaying a logical relationship between the lenses and the traffic movements they control. More specifically, the left-turn arrow indications are located to the left of the solid ball indications just as the left-turn movement is located to the left of the through movement.

Number and Location of PPLT Heads

The minimal guidance provided by MUTCD permits many different PPLT signal designs. In fact, MUTCD states that an exclusive head is not required (*1*) for the left-turn movement. If an exclusive head is not provided, the guidelines imply that a shared head must be provided. One advantage of the shared-head arrangement is that the shared head can serve as one of the two required through movement heads, thereby minimizing the total number of heads and their associated costs. A disadvantage of the shared-head arrangement is that it may be less clear to the motorist which signal head is controlling his or her entrance to the intersection.

Auxiliary Signing

At some intersections, auxiliary signs have been mounted near the PPLT signal head to ensure that drivers understand the intended meaning of its signal indications. MUTCD (*1*) suggests that no information sign is necessary; however, if one is used it must be the R10-12 sign [Left Turn Yield On Green (symbolic green ball)]. A study of 30 intersections conducted by Agent (*5*) indicated that auxiliary signs made no difference in the number of left-turn accidents. Based on this finding, Agent recommended that auxiliary signing not be used. Similar recommendations were made by the Florida Section of ITE (*2*). Both groups indicated that appropriate driver education regarding PPLT signal displays would be more effective than auxiliary signing.

Protected and Permitted Signal Head Design Types

Because of the generality of MUTCD guidelines, many possible combinations of signal head lens arrangements (i.e., horizontal, vertical, or cluster) and lane location (i.e., shared or exclusive) may be used to define the signal head design. At present, five PPLT signal design types are used in Nebraska. A sixth type is being considered for some locations. A description of each follows:

- *Exclusive horizontal PPLT signal design.* This design, shown in Figure 2, has horizontal heads centered over each left and through lane.
- *Exclusive cluster and vertical PPLT signal design.* This design, shown in Figure 3, is an exclusive-head arrangement with vertical heads for the through movements and a cluster head for the PPLT movement.
- *Exclusive vertical PPLT signal design.* This design, shown in Figure 4, is similar to that shown in Figure 3 except that a vertical head is used to control the PPLT movement instead of the cluster head.
- *Shared cluster and vertical PPLT signal design.* For this design, shown in Figure 5, each signal head is placed over a lane line and used to control traffic in the lanes on either side of the line. This design is quite similar to that recommended by FHWA (*6*), the

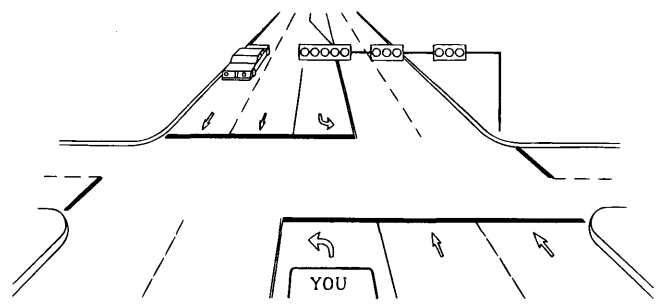


FIGURE 2 Exclusive horizontal PPLT signal design.

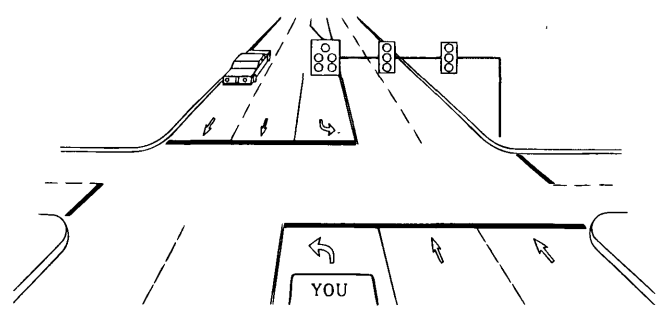


FIGURE 3 Exclusive cluster and vertical PPLT signal design.

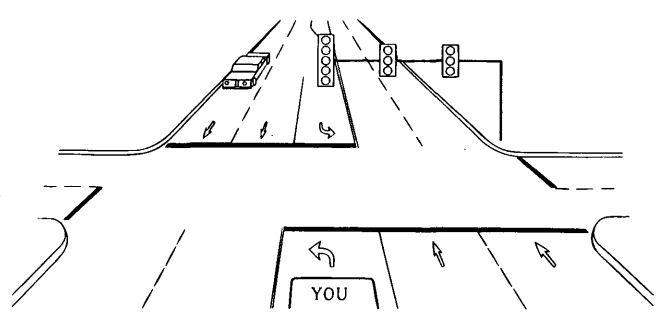


FIGURE 4 Exclusive vertical PPLT signal design.

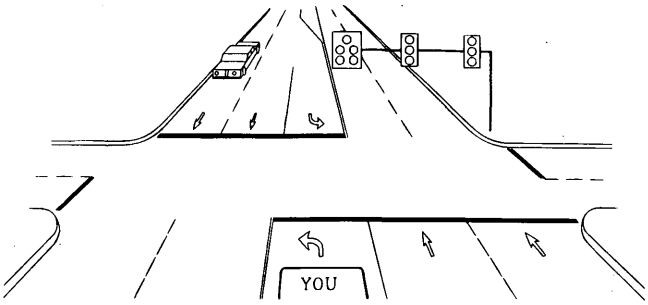


FIGURE 5 Shared cluster and vertical PPLT signal design.

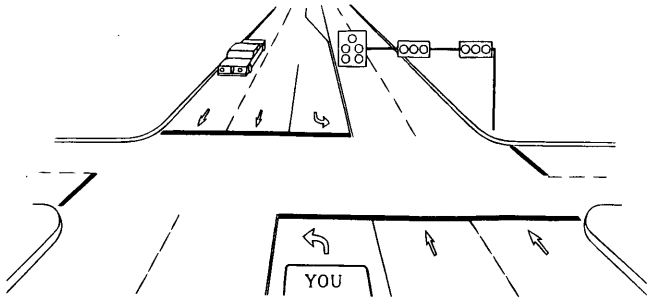


FIGURE 7 Shared cluster and horizontal PPLT signal design.

Florida Section of ITE (*2*), and Agent (*5*), although the latter two sources do not include a through movement signal head over the curb lane line.

- *Shared horizontal PPLT signal design.* This design, shown in Figure 6, has horizontal heads over each lane line.
- *Shared cluster horizontal PPLT signal design.* This design, shown in Figure 7, combines the cluster and horizontal head designs in a shared use arrangement.

As shown in Figures 2 through 7, the shared and exclusive designs use one PPLT head and two through movement heads. Three heads are commonly used in Nebraska but may not be common in other areas (i.e., some states use two heads in a shared design).

DRIVER SURVEY

The operational performance of a traffic control device is typically evaluated in terms of conspicuity, recognition, and comprehension. Comprehension is a measure of how well the motorist understands the meaning of the control device message as intended by its designer. The degree of comprehension of a device can be measured by the number of motorists that correctly understand its message. For this research, driver comprehension of the PPLT design was assessed with a survey of licensed drivers.

Survey Form

The survey design followed that used by Williams et al. (*4*), in which one perspective view of an intersection approach was shown at the top of the page and two multiple-choice questions asked the correct identification of a particular indication type. More specifically, a perspective view of an intersection approach was drawn from the viewpoint of the first-to-arrive left-turn driver. To reinforce the intended orientation of the respondent with respect to the intersection, the word "YOU" was drawn in the left-turn lane.

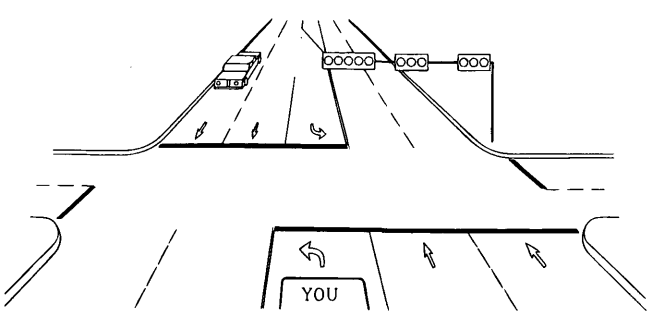


FIGURE 6 Shared horizontal PPLT signal design.

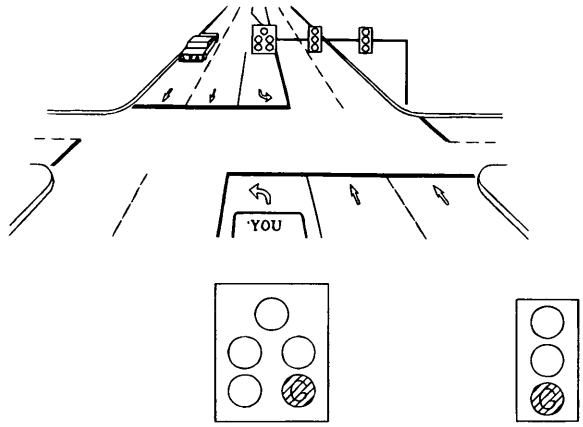
As the resolution of this perspective view was too low to indicate the signal indications clearly, an enlarged view of each head and its lighted indication was placed just below the perspective view. Below this enlarged view was a multiple-choice question with four possible responses regarding the appropriate driving action. To fully use space on the questionnaire, a second enlarged view (showing a different signal indication combination) and multiple-choice question were placed below the first question. A sample questionnaire is shown in Figure 8.

The survey contained questions about the six PPLT signal design types shown in Figures 2 through 7. An auxiliary sign was included in the survey for one PPLT design type. Although auxiliary signs of this kind are rarely used at intersections in Nebraska, there are a few locations that use these signs with the PPLT design shown in Figure 3. The sign is to the right of the PPLT head on the mast arm. The message on the sign is "Left-Turn Yield on Green (symbolic green ball)" (MUTCD R10-12).

Differences in driver understanding among the seven PPLT designs could be attributed to a combination of the PPLT signal design and the indication presented. Therefore, to test fully the effectiveness of the seven PPLT designs, the survey was designed to evaluate each PPLT design under each unique indication combination. The four different combinations considered include

- *Permitted* left-turn indication (green ball for both the left-turn and through movements);
- *Protected/MUTCD* left-turn-only indication (left-turn green arrow and through red ball), consistent with MUTCD specifications;
- *Overlap* left-turn and through indication (left-turn green arrow and through green ball); and
- *Protected/Modified* left-turn-only indication. The modified indication displayed only the green arrow in the PPLT head (i.e., without the red ball). This form is intended to overcome driver confusion from the simultaneous display of a green arrow and red ball in the same PPLT head.

The enlarged view of the signal heads was colored on the survey form to be consistent with the lit lens or lenses for each combination. Because only two questions appeared on each form, only two of the four indications were presented to each interviewee.



If you are waiting to turn left and see the above signal indication...
(please circle the letter corresponding to your response)

a. you are not allowed to turn left.

b. you are allowed to turn left; however, you must wait for a large enough opening in the oncoming traffic before doing so.

c. you are allowed to turn left since the oncoming traffic must stop.

d. you are not sure whether or not a left-turn is allowed.

If you are waiting to turn left and see the above signal indication...

a. you are not allowed to turn left.

b. you are allowed to turn left; however, you must wait for a large enough opening in the oncoming traffic before doing so.

c. you are allowed to turn left since the oncoming traffic must stop.

d. you are not sure whether or not a left-turn is allowed.

FIGURE 8 Sample survey form—driver understanding questions.

The back side of the questionnaire contained several demographic questions used to determine the age, driving experience, sex, rural or urban residence, and level of education of the respondent. The demographic portion of the questionnaire is shown in Figure 9.

Distribution Method

Several measures were taken to ensure a representative sample of the appropriate driving population in Nebraska. Since drivers in the urban areas of Nebraska have more exposure to PPLT signal designs than rural drivers, the questionnaire was administered in three of Nebraska's largest cities, Omaha, Lincoln, and Grand Island.

The survey was administered in person at the local Department of Motor Vehicles (DMV) driver's license testing facility in each city. Experience in conducting surveys at DMV testing facilities has revealed that it has several strong advantages over other places. One advantage is that it brings an unbiased sample of the driving population to the interviewer—unbiased in the sense that the people are at the facility on the basis of their birth date.

Another advantage is that the response rate tends to be high. Interviewees at the DMV are receptive to the survey because (*a*) they are mentally prepared to answer traffic-related questions, and (*b*) they have to wait for 5 or 10 min anyway. Filling out a ques-

Please provide us some general information about you to help us classify your response. This information is confidential, in fact, we do not need your name or address.

(please circle the letter corresponding to your response)

Age:

a. 25 or under
b. 26 to 35
c. 36 to 45
d. 46 to 55
e. 56 to 65
f. 66 to 75
g. 76 or over

Number of Years You Have Been Driving:

a. 5 or less
b. 6 to 10
c. 11 to 15
d. 16 to 20
e. 21 to 25
f. 26 to 30
g. 31 or more

Residence:

a. within city limits
b. outside city limits

Sex:

a. Female
b. Male

Education:

a. less than 12 years
b. high school diploma
c. some college work
d. college degree

Thank you for completing this survey. Your response will be used to help us determine the types of traffic signal indications that work best. We will be sharing this information with various state and city agencies in Nebraska.

FIGURE 9 Sample survey form—demographic questions.

tionnaire is not deemed to be an inconvenience. As a consequence of using the DMV, a 90 percent response rate was achieved.

Statistical Analysis Approach

The factors affecting driver response accuracy were identified using analysis of variance techniques. The analysis of variance was conducted using the Categorical Data Modeling (CATMOD) procedure in the SAS System (*7*). All statistical tests were conducted using a 95 percent level of confidence (i.e., $\alpha = 0.05$).

Potential bias from demographic diversity in the responses was controlled by including a wide range of demographic questions on the survey forms. Demographic factors found to be correlated with driver understanding were included in the statistical analyses, and all others were excluded. Bias associated with small sample size was minimized by using the maximum-likelihood analysis option available in CATMOD.

Analysis Results

Survey Demographics

In total, 1,610 completed questionnaires were obtained during a 3-week period in May 1992. Because each survey form contained two

PPLT design questions, 3,220 questions were considered in the analysis. A summary of the demographic characteristics of the survey sample is provided in Table 1.

At first glance, it may appear alarming that only 70 percent of the survey respondents correctly understand the meaning of the PPLT signal designs [a similar proportion of correct responses was found by Williams et al. (*4*)]. However, it must be remembered that the respondents were answering a questionnaire with a limited source of information (i.e., a black-and-white, two-dimensional perspective drawing with colored signal indications). It is likely that drivers receive other visual clues at intersections, which increase the likelihood of making the correct response. This hypothesis could be confirmed only by a detailed study of driver performance under real-world conditions. As noted by Williams et al. (*4*), however, each signal indication should, on its own merits, be understandable to drivers. The survey conducted for this research provides considerable insight in this regard.

Several trends apparent in Table 1 bear further discussion. In particular, there is a trend toward decreased understanding of the PPLT designs with increased age and driving experience. There is also a trend toward better understanding with more education. There does not appear to be strong differences between male and female drivers or between rural and urban drivers. These trends were considered in the analysis of driver response, as described in the next section.

Comparison of PPLT Designs

The principal focus of this survey was a comparison of driver understanding of the six PPLT designs shown in Figures 2 through 7. A seventh design was included to determine the effect of auxiliary signing. The proportion of correct responses is shown in Table 2.

Design Comparisons The analysis of the PPLT designs was based on the differences in responses for each signal display indication. In the fourth column in Table 2, the responses shown apply to the protected/MUTCD indication (i.e., green arrow with red ball) survey question. Differences between this indication and the protected/modified (i.e., green arrow, no red ball) are examined later.

As shown in the row total of Table 2 (right column), drivers appear to have the best understanding of the exclusive vertical PPLT design (Figure 4). The difference in results for this design and those for the least understood design is about 8 percent. A closer examination of the difference between each design pair indicates that none is significantly different. Although the differences shown in Table 2 suggest that some designs are better understood, a larger number of responses would be needed to confirm these trends.

With regard to differences in understanding the various indications, the column total in Table 2 indicates that the overlap indica-

TABLE 1 Summary of Survey Demographics

Demographic Factor	Level	Number of Respondants	Proportion of Correct Responses
Location	Grand Island	212	0.667
	Omaha	626	0.712
	Lincoln	772	0.716
Age	25 or under	594	0.743
	26 to 35	380	0.738
	36 to 45	329	0.676
	46 to 55	130	0.635
	56 to 65	76	0.671
	66 to 75	53	0.632
	76 or over	14	0.679
	not provided	34	0.559
Driving Experience	5 or less	382	0.716
	6 to 10	287	0.765
	11 to 15	204	0.733
	16 to 20	199	0.711
	21 to 25	161	0.677
	26 to 30	108	0.616
	31 or more	216	0.662
	not provided	53	0.708
Residence	Rural	233	0.721
	Urban	1341	0.709
	not provided	36	0.583
Sex	Female	756	0.695
	Male	720	0.729
	not provided	134	0.668
Education	less than 12 years	171	0.678
	high school diploma	334	0.659
	some college work	561	0.728
	college degree	515	0.732
	not provided	29	0.638

TABLE 2 Driver Understanding of Selected PPLT Designs

PPLT Design (Figure No.)	Display Indication[c]			Total
	Permitted	Overlap	Protected	
3 w/sign	0.824[a] <- high 119[b]	0.409 115	0.664 119	0.635 353
2	0.796 113	0.658 <- high 114	0.619 113	0.691 340
3 no sign	0.658 114	0.643 112	0.798 114	0.700 340
4	0.800 115	0.500 <- low 114	0.826 115	0.709 <- high 344
5	0.658 114	0.539 115	0.851 <- high 114	0.682 343
6	0.761 117	0.607 117	0.530 <- low 117	0.632 <- low 351
7	0.626 <- low 115	0.500 <- low 116	0.835 115	0.653 346
Total	0.732 807	0.550 803	0.731 807	0.671 2417

[a]Proportion of correct responses.
[b]Number of responses.
[c]This summary of responses includes the responses to only 3 of the 4 indication combinations: Permitted, Overlap, and Protected/MUTCD.

tion is least understood; only about one-half of the drivers surveyed answered this question correctly. Fortunately, a closer examination of the responses to this question indicates that most of the respondents who erred chose the safer course of action, which was to wait for a gap in oncoming traffic. Of course, in the context of the total intersection, driver understanding of the overlap indication is probably much higher than suggested by this survey. During the leading protected left-turn sequence (common in Nebraska), left-turn drivers become accustomed to the green arrow and the stopped opposing traffic. When the green ball subsequently joins the green arrow during the overlap phase, drivers are less likely to stop and yield incorrectly as suggested by the survey.

Demographic Effects The effects of the demographic factors listed in Table 1 were also considered in the analysis. On the basis of this analysis, it was determined that several factors had a statistically significant effect on driver understanding of a PPLT design. A closer examination of these factors indicated that driver age explained more of the variation in driver understanding than years of driving or education. Thus, age was kept in the analysis to the exclusion of the other two factors. In general, driver understanding decreased with increased driver age.

Comparison Among Signal Head Locations, Lens Arrangements, and Sign Use

A secondary focus of this survey was an examination of the effect of signal head location, lens arrangement, and sign use on driver understanding of the six PPLT designs shown in Figures 2 through 7. A seventh design was included to determine the effect of auxiliary signing. The proportion of correct responses to each of these factors is presented in Table 3.

Signal Head Location In the analysis of signal head location, the PPLT designs having the PPLT head centered over the left-turn lane (exclusive) were compared with those having the head over the lane line (shared). On the basis of this analysis, it was determined that more drivers understand the PPLT display when the PPLT head is centered in the left-turn lane. The difference in response rates indicates that about 4 to 5 percent more drivers are able to understand the exclusive head location than the shared head. This difference was found to be statistically significant ($p = 0.033$); however, it may be too small to have a practical significance.

Lens Arrangement The analysis of lens arrangement compared the cluster, horizontal, and vertical PPLT head displays (shown in Figure 1). This analysis indicated that the overall differences between the three arrangements were not significant ($p = 0.28$). There were, however, significant differences between the lens arrangements for the permitted and the protected indications. The survey results suggest that significantly more drivers understand the permitted indication in vertical and horizontal arrangements ($p = 0.001$) than in the cluster arrangement. The results also suggest that significantly more drivers understand the protected/MUTCD indication in the cluster and vertical arrangements ($p = 0.0001$) than in the horizontal arrangement.

Sign Use The analysis of sign use compared the exclusive cluster and vertical (Figure 3) with and without the use of an auxiliary sign (i.e., MUTCD R10–12). The results of this analysis indicate that a significantly higher correct response rate occurred with no sign ($p = 0.028$). This finding suggests that designs with no sign may be better understood than designs with a sign. However, this trend is not consistent among the signal indications. For the permitted indication, the sign appears to help driver understanding,

TABLE 3 Effect of Head Location, Lens Arrangement, and Sign Use on Driver Understanding

Factor	Levels	Display Indication[c]			Total
		Permitted	Overlap	Protected	
Head Location	Exclusive (Centered)	0.751[a] 342[b]	0.600 340	0.749 342	0.700 1024
	Shared (Lane Line)	0.682 346	0.549 348	0.734 346	0.656 1040
	Total	0.717 688	0.574 688	0.743 688	0.678 2064
Lens Arrangement	Cluster	0.658 228	0.590 227	0.825 228	0.691 683
	Horizontal	0.778 230	0.632 231	0.574 230	0.661 691
	Vertical	0.800 115	0.500 114	0.826 115	0.709 344
	Total	0.735 573	0.589 572	0.724 573	0.683 1718
Sign Use[d]	No Sign	0.658 114	0.643 112	0.798 114	0.700 340
	Sign	0.824 119	0.409 115	0.664 119	0.635 353
	Total	0.742 233	0.524 227	0.730 233	0.667 693

[a]Portion of correct responses.
[b]Number of responses.
[c]This summary of responses includes the responses to only 3 of the 4 indication combinations: Permitted, Overlap, and Protected/MUTCD.
[d]The analysis of Sign Use considered only the exclusive-cluster/vertical PPLT design (i.e., Figure 3) with and without an auxiliary left-turn sign. The sign used was a "Left-Turn Yield on Green (symbolic green ball)" (MUTCD R10-12).

whereas during the overlap and protected indications, it appears to confuse them. This finding is consistent with that of Hummer et al. (*8*), who found that slightly more drivers understood the permitted indication when it was accompanied by a sign, but many more drivers were confused by the sign during the protected and overlap indications.

Comparison of MUTCD and Modified Forms of Protected Signal Display Indication

Examination of the column totals in Table 4 suggests that the modified form of the protected indication is associated with greater driver understanding than the MUTCD indication. Overall, about 10 percent more drivers are able to determine the correct response to the modified indication. The analysis indicated that this difference is statistically significant ($p = 0.0003$).

Closer examination indicates that the greatest benefit of the modified display is realized by drivers faced with horizontal PPLT designs (Figures 2 and 6). For these two horizontal PPLT designs, it appears that about 25 percent more drivers are able to understand the protected indication when the red ball is *not* shown with the green arrow. Similarly, about 12 percent more drivers are able to understand the exclusive cluster and vertical PPLT design (Figure 3) when the modified display is used. Examination of the other designs indicates that the modified display increases driver understanding in every case.

CONCLUSIONS AND RECOMMENDATIONS

The survey of driver understanding indicated that the exclusive vertical PPLT design (Figure 4) is correctly understood by the highest proportion of drivers. Of the three indications considered (i.e., permitted, overlap, protected/modified), the overlap indication is understood by only about one-half of all drivers, the smallest number for any of the indications.

An analysis of the effects of PPLT signal head location and sign use on driver understanding revealed several interesting trends. The exclusive head location increased driver understanding by about 4 to 5 percent over the shared head location. The analysis of sign use compared the exclusive cluster and vertical (Figure 3) with and without a sign. The sign considered was the "Left-Turn on Yield on Green (symbolic green ball)" (MUTCD R10-12). This analysis indicated that designs with a sign decrease driver understanding by about 6.5 percent. It was found that the use of a sign tends to confuse more drivers during the overlap and protected phases than it helps during the permitted phase.

An examination of the differences between the MUTCD and modified form of the protected PPLT indication revealed that drivers understood the modified form (i.e., green arrow and no red ball) better. The most significant difference was found for the horizontal PPLT designs, which 25 percent more drivers understood. This difference is statistically significant and of sufficient magnitude to be of practical significance.

In recognition of the significance of the findings regarding the modified protected indication, a study of driver performance, under

TABLE 4 MUTCD versus Modified Form of Protected Signal Display Indications

PPLT Design (Figure No.)	Display Indication[c]		Total
	MUTCD	Modified	
2	0.619[a] 113[b]	0.877 114	0.749 227
3 no sign	0.798 114	0.911 112	0.854 226
4	0.826 115	0.851 114	0.838 229
5	0.851 114	0.852 115	0.852 229
6	0.530 117	0.778 117	0.654 234
7	0.835 115	0.836 116	0.836 231
Total	0.743 688	0.850 688	0.797 1376

[a]Proportion of correct responses.
[b]Number of responses.
[c]The PPLT design with the sign was excluded from this analysis.

either real world or simulated conditions, should be conducted to evaluate the level of confusion that apparently exists between it and the existing MUTCD version of the protected indication.

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