Study of Urban Guide Sign Deficiencies

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A survey administered to a sample of 662 volunteers at the 1990 Houston Auto Show compared alternative methods for providing lane assignment information on urban guide signs. Signing elements that were studied included the white down-arrow used for optional lane usage; the black down-arrow used in the Exit Only lane; the organization of route numbers and destinations; a comparison of the *Manual on Uniform Traffic Control Devices* diagrammatic guide sign and modified diagrammatics with separate arrows for each lane and with arrow shafts exceeding the number of lanes; and the use of Next Left and Next Right on conventional guide signs. The conventional diagrammatic guide sign was found to be less effective in communicating lane assignment than the modified diagrammatic signs tested. Downward arrows failed to communicate the intended optional usage message. The communication of optional exit lanes was confused by the number and position of arrow shafts displayed. Common routes displayed on an exit guide sign were less effectively displayed side by side than vertically arrayed. The array of information on diagrammatic signs was determined to equal in importance the information on the diagrammatic. Next Right and Next Left were interpreted as mandatory exits by a significant portion of the respondents.

Increased traffic has generated greater demand on existing freeways and their information systems. For example, exit ramps in many urban areas are no longer capable of handling the traffic for which they were designed. The demand today calls for two-lane exit ramps. However, signing for two-lane exits has not been established as a standard practice. In some cases, terminology used on freeway signs is not consistent. Freeways often have a local name and a route number, and mixed use is confusing to the motorist unfamiliar with it. Beltway, loop, circle, belt, and bypass are all descriptors used in various parts of the country to describe certain freeways. Drivers must read and respond to trailblazers for arterial routes while usually operating under a heavy driver work load. Geometric features such as bifurcations are complex and drivers require a sufficient amount of information processing time to respond correctly.

In this study, a survey was conducted to gain more information about several guide sign deficiencies that had been identified in previous research. It was intended that this survey compare alternative methods for providing lane assignment information on guide signs.

STUDY METHOD

Data were collected during the Houston Auto Show held March 24–April 1, 1990. Each survey consisted of an individual presentation of seven depictions of guide signs and associated questions. The questions were in the form of statements. Respondents were to indicate agreement or disagreement with statements regarding which lane or lanes could be used to exit or to continue on the interstate. On each computer-generated sign the route numbers and destination cities were fictional to prevent respondents from recognizing a specific sign. However, the stimulus material presented consisted of representations of guide sign formats that are actually being used and are in compliance with the *Manual on Uniform Traffic Control Devices* (MUTCD).

Two different sets of surveys, Set A and Set B, were each administered to approximately half of the respondents. Four signs and their associated questions were duplicated on both sets of surveys. Each of the two sets was further divided into four subsets. The subsets differed only in the order of questions. This procedure was to ensure that no carryover effects influenced results. Otherwise, the signs and associated questions were identical.

Topics Investigated

Signs A, B, and C (Figure 1) were used to compare understanding of signing elements and overhead lane positions on two-lane exiting guide signs. Of specific interest was the white down-arrow for optional lane usage, the black down-arrow in the Exit Only lane, organization of route numbers and destinations, and overhead lane position.

Signs D and E (Figure 2) compared understanding of the MUTCD diagrammatic guide sign and the modified diagrammatic with separate arrows for each lane. Sign F (Figure 3) dealt primarily with understanding of Next Left on conventional guide signs. Signs G and H (Figure 4) dealt with understanding the modified diagrammatic when the number of arrow shafts exceeded the number of lanes shown. Also of interest were how the detail designs of signing elements affected understanding of a single-lane, optional left exit guide sign and two-lane, Pull-Through arrowheads.

Signs G and H tested the effect of a right-hand guide sign sharing the sign bridge with a four-lane modified diagrammatic. Of specific interest was the understanding of Next Right in conjunction with the fourth arrow.

Because the modified diagrammatic is less common, another objective was to test the effect of a prior explanation of how to interpret its meaning. It was predicted that a brief explanation would greatly enhance the understanding of lane usage. Five signs (D, G, H, I, and J) included the modified diagrammatic. Half of the respondents were termed "the informed group." They were shown a sample diagrammatic, not used in the survey, and a printed explanation of how to read and interpret it. The other half of the participants, termed

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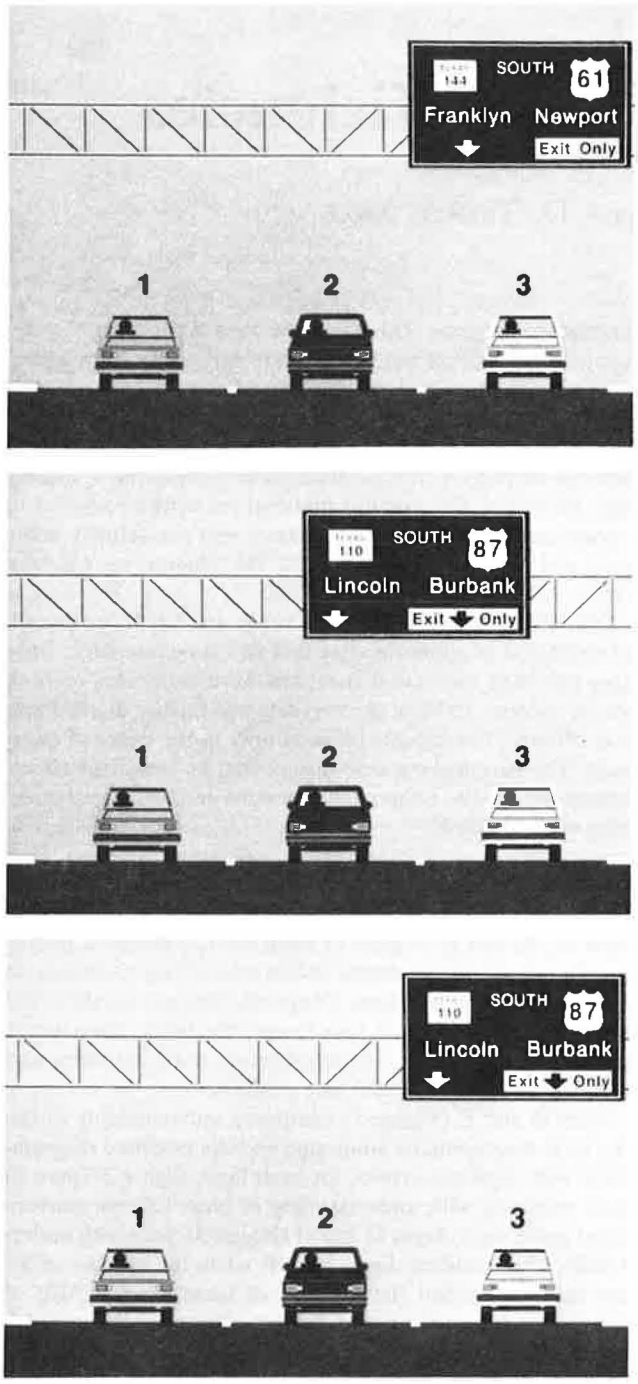

FIGURE 1 Signs A, B, and C (*top*, *middle*, and *bottom*, respectively) were used to compare comprehension of sign elements and positioning on two-lane exit signs.

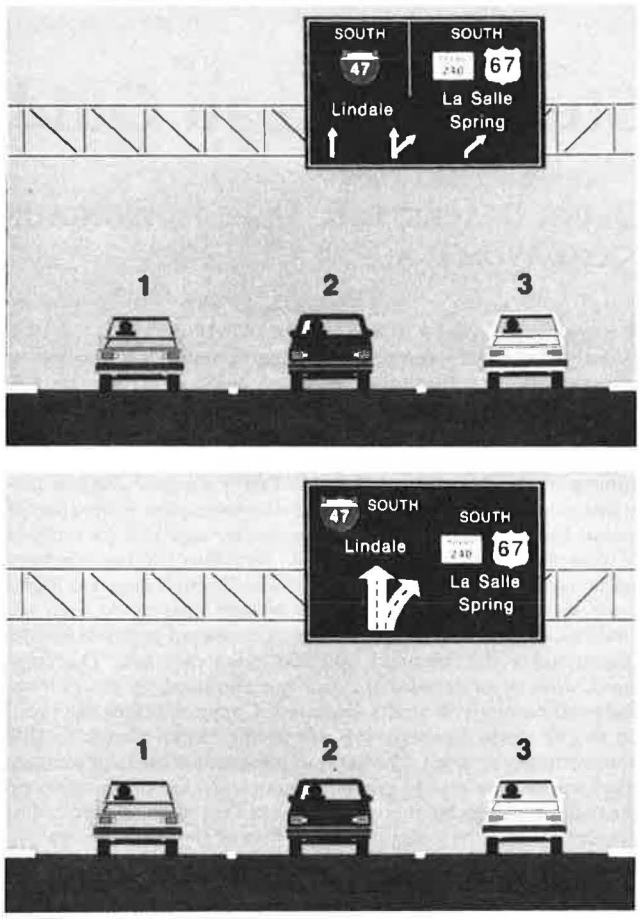

FIGURE 2 Signs D and E (*top* and *bottom*, respectively) were used to compare comprehension of MUTCD and modified diagrammatics.

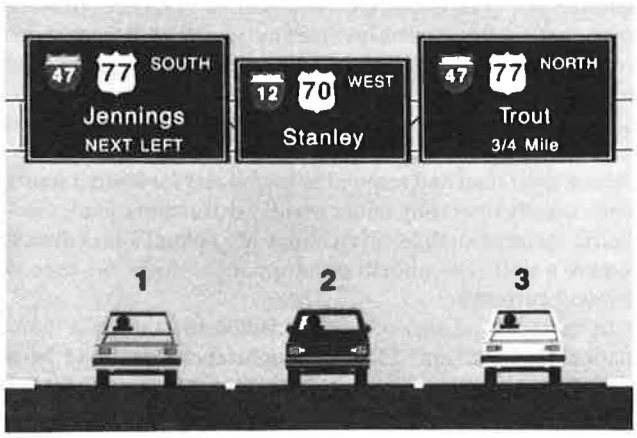

FIGURE 3 Sign F was used to determine comprehension of Next Left on conventional signs.

"the uninformed group," received no explanation. Each group was given the same signs and questions.

Procedure

Two staff members were present to administer the survey. One person was in charge of administering Set A, while the other administered Set B. Informed and uninformed surveys were given in sets of fours. Hence, four uninformed surveys were followed by four informed surveys. The participants were told that there were no right or wrong answers and that their responses would be confidential. They were then shown the depictions of guide signs and asked to check each statement they deemed true based on their understanding of the

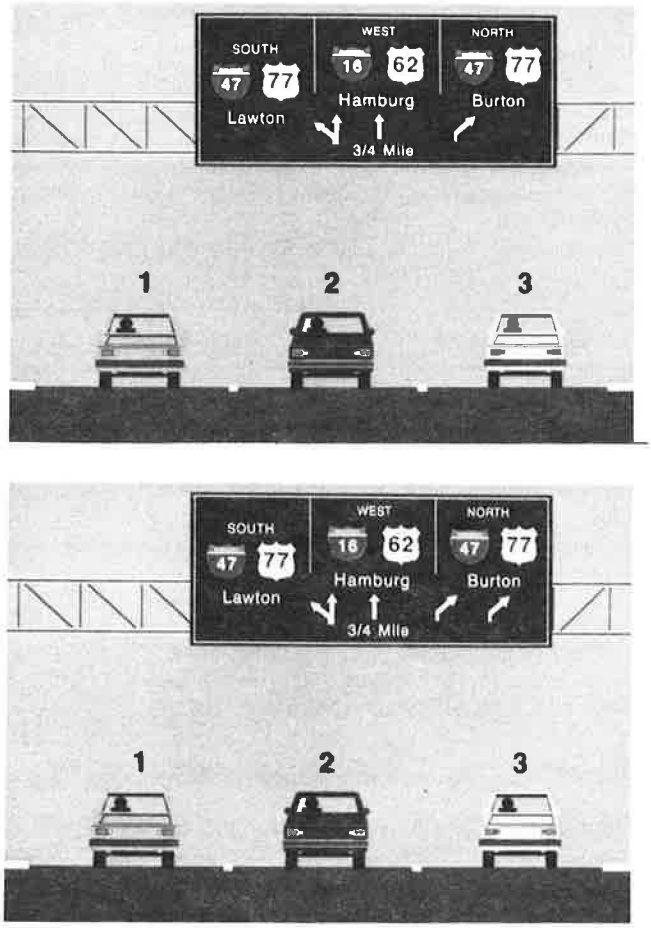

FIGURE 4 Signs G and H (*top* and *bottom*, respectively) were used to determine comprehension when number of arrow shafts exceeded number of lanes.

signs. It was explained that there could be more than one true statement for a set of statements relating to a given figure. A total of 662 surveys were completed.

Problems in Administration

Several problems were encountered during the survey. One major problem was the noise that was generated from the surrounding booths. The traffic safety section at the automobile show consisted of 18 different booths, including two seat belt convincers, an air compressor to refill air bags, and a singing puppet show. This made it difficult to hear, and it may have affected the respondents' ability to concentrate while completing the survey. It should be noted that the noise factor may have also affected the comparison results of the uninformed and informed participants. Originally the staff members were going to read aloud the paragraph informing the motorist how to read a diagrammatic sign properly. Because of the loud noise from surrounding booths, it was impossible to do so. Since motorists have varying literacy skills, this may be a factor to consider in the analysis.

It should also be noted that several of the participants may not have understood the meaning of the words "urban" and "downstream." "Urban" was used in the second question in the demographic section. The question was, "How often do you travel on urban freeways?" The word "downstream" was used for Sign G only, and the question was, "What do you think happens downstream that made this difference possible?"

Data Analysis

The data collected at the automobile show were placed into a database file and later converted into Statistical Analysis System (SAS) format for further analysis. The SAS program converted frequencies into percentages and determined if a significant difference existed between groups in answering the same question.

Description of Respondents

In all, 662 visitors to the Auto Show volunteered to participate in the survey. Demographic data were collected but were not used as a basis for selection other than to ensure that all were frequent travelers on urban freeways. The characteristics of the sample are presented in Table 1.

RESULTS FOR SIGNS A, B, AND C

Objectives

The objectives of this comparison were as follows:

1. To determine drivers' understanding of the downward white arrow on the left as an indicator of optional usage of Lane 2,

TABLE 1 Description of Respondents

Gender	%	Education	%
Male	69.9	Less than High School	5.5
Female	30.1	High School	19.2
		Some College	30.9
		College Degree	44.4
Ethnicity		Years Driving	
Anglo	76.6	Less than 1	4.7
Black	5.3	1 to 5	16.0
Hispanic	9.6	More than 5	79.3
Other	8.5		
Age		Urban Freeway Driving	
Less than 25	28.3	Occasionally	17.3
25 to 55	65.7	Often	82.7
Over 55	6.1		

2. To determine if the black down-arrow embedded in the Exit Only message clarified the optional usage of Lane 2 (by emphasizing Lane 3 is for exit),
3. To determine if the position of the overhead sign was a factor in understanding, and
4. To determine if the side-by-side array of route numbers and destinations led to the assumption that Lanes 2 and 3 led to different routes.

Questions Pertaining to Signs A, B, and C

Participants were asked to respond to the following statements. The results are shown beneath each statement.

1. Lane 2 may be used to exit to Texas 144 to Franklyn (Texas 110 to Lincoln), but not to US-61 to Newport (US-87 Burbank).

Sign	*True*	*False*	*Sample Size ($p < .05$)*
A	51.60	48.40	651
B	64.35	35.65	331
C	68.62	31.38	325

2. Either Lane 2 or 3 may be used to exit to US-61 South (US-87 South).

Sign	*True*	*False*	*Sample Size ($p < .02$)*
A	12.90	87.10	651
B	18.13	81.87	331
C	11.08	88.92	325

3. If you are in Lane 3 you *must* take the next exit.

Sign	*True*	*False*	*Sample Size*
A	90.00	10.00	651
B	91.24	8.76	331
C	90.15	9.85	325

4. Lane 2 may be used to continue on IH-47 South. (Respondents were instructed that they were driving south on IH-47.)

Sign	*True*	*False*	*Sample Size ($p < .001$)*
A	75.50	24.50	649
B	74.85	25.15	330
C	62.15	37.85	325

Discussion of Results

Question 1 addressed the fourth objective: to determine if a side-by-side array of route numbers and destinations lead to the assumption of route separation. A majority of drivers believed that Lane 2 led only to Franklin (Texas 144). When the downward black arrow appeared (Signs B and C) this seemed to increase confusion, as if Lane 3 were reserved for US-87 to Burbank. This result may be because some drivers spatially clustered information with each arrow. Thus, the information on the left side of the sign is associated with the left arrow, while the information on the right side of the sign is associated with Exit Only or Exit Only with an arrow.

Question 2 addressed the first objective. Over 80 percent did not understand that the white down-arrow meant Lane 2 could be used as an exit. Moving the sign such that the white arrow was over Lane 2 (Sign C) did not improve understanding. In fact, there was significantly poorer understanding of Sign C than B.

For Question 3, 90 percent understood that Lane 3 traffic must exit. For Question 4, 75 percent agreed that Lane 2 traffic could continue when the sign was over Lane 3, but only 62 percent agreed when the sign was over Lane 2. Changing the sign position had a negative impact on understanding.

In summary, the data suggest that the white arrow does not connote optional usage. The black arrow did not aid in connoting optional usage. Positioning the sign over Lane 2 led to more misunderstanding than when it was over Lane 3. A side-by-side array of route numbers and destinations may be confusing when the down-arrow appears directly under one or both routes.

RESULTS FOR SIGNS D AND E

Objectives

The objectives of this set of questions were as follows: to compare the effectiveness of the conventional diagrammatic (Sign E) and the modified diagrammatic (Sign D) and to determine the degree to which instructions on how to read diagrammatic signs improved performance.

Questions Pertaining to Signs D and E

1. If you are in Lane 3 you *must* take the next exit.

Sign	*True*	*False*	*Sample Size ($p = .001$)*
D	82.07	17.93	329
E	71.43	28.57	322

2. Lane 2 may be used to exit to Texas 240 to LaSalle, but not to US-67 to Spring.

Sign	*True*	*False*	*Sample Size*
D	14.59	85.41	329
E	11.15	88.85	323

3. Either Lane 2 or 3 may be used to exit to US-67 South.

Sign	*True*	*False*	*Sample Size ($p < .001$)*
D	88.75	11.25	329
E	75.85	24.15	323

4. Lane 2 may be used to continue on IH-47 South.

Sign	*True*	*False*	*Sample Size*
D	92.71	7.29	329
E	90.09	9.91	323

Discussion of Results

Question 1 asked if Lane 3 traffic must exit. Significantly more respondents understood the modified diagrammatic for this application. Training had no effect on the percentages. Thus, the separate, modified up-arrow over Lane 3 better communicated that Lane 3 must exit. However, the level of understanding was below that reported for Signs A, B, and C where Exit Only appeared over Lane 3.

Question 2 was analogous to Question 1 in the previous set of signs. Over 85 percent understood that Lane 2 applied to both routes (Texas 240 and US-67). Note that here destinations are arrayed one above the other. There was no difference between the modified and conventional diagrammatic for this application.

Question 3 tested whether respondents thought Lane 2 could be used to exit to US-67. With the modified diagrammatic, significantly more respondents (13 percent) were correct than with the conventional diagrammatic. Again, training did not significantly improve the performance with the modified diagrammatic sign.

Question 4 asked if Lane 2 could be used to continue on the interstate. Ninety percent of both groups agreed. Training had no effect. It is interesting to note that these signs had pull-through route designations unlike those in Signs A, B, and C. This information coupled with the modified diagrammatic arrows increased the correct responses by at least 17 percent.

In summary, the modified diagrammatic, with separate arrows for each lane, resulted in better performance when applied to whether Lane 3 must exit or whether Lane 2 may be used to exit. When the two exit destinations were not side by side and did not have down-arrows, as in Signs A, B, and C, drivers were less likely to assume that Lane 2 led to one route and Lane 3 to another.

Training on how to read diagrammatic signs was predicted to increase understanding. However, instruction appeared to have little or no effect. One possible explanation for this finding could be the conditions of administration, which required the respondents to read the explanation and not orally demonstrate understanding. The exercise failed to teach many drivers the basic principles.

RESULTS FOR SIGN F

Objective

The objective of this set of questions was to determine if a sign over Lane 1 that displayed Next Left would imply that exiting was optional or mandatory.

Questions Pertaining to Sign F

1. Lane 1 traffic *must* exit to IH-47 South.
2. Lane 2 traffic may continue on IH-12 West.
3. Lane 1 traffic may exit to IH-47 South or may continue on IH-12 West.

Discussion of Results

The results are given in the following table:

Question	*True*	*False*	*Sample Size*
1	29.30	70.70	651
2	86.80	13.20	651
3	64.50	35.50	651

In answer to Question 1, 70.7 percent understood that exiting was not required, but a surprising 29.3 percent thought Lane 1 was for exiting only. Question 3 was essentially the same question restated in a different form. Here 64.5 percent understood that Lane 1 exiting was optional.

Question 2 asked if Lane 2 traffic could continue on the interstate. Although 86.8 percent were correct, one might have expected near perfect performance.

In summary, Next Left over Lane 1 was misinterpreted by almost a third of the drivers as being mandatory.

RESULTS FOR SIGNS G AND H

Objectives

One objective of this set of questions was to determine the effects of displaying modified diagrammatic arrows when there are more arrows than lanes shown. The actual situation was one of an added right-hand lane downstream of the overhead sign. The drivers were not given this information but were asked to speculate on why there were more arrows than lanes. Another objective was to determine the extent to which poor formatting of information and overhead placement of information in the wrong lane affects interpretation of a left, optional usage exit shown by a modified diagrammatic.

Questions Pertaining to Signs G and H

1. Lane 2 traffic may exit to IH-47 *North*.

Sign	*True*	*False*	*Sample Size* ($p = .0001$)
G	42.86	57.14	329
H	14.51	85.49	324

2. Lane 1 traffic may continue on IH-16 West.

Sign	*True*	*False*	*Sample Size*
G	56.10	43.90	328
H	54.01	45.99	324

3. Lane 1 traffic may exit to IH-47 *South*.

Sign	*True*	*False*	*Sample Size*
G	77.81	22.19	329
H	79.63	20.37	324

4. Lane 1 traffic *must* exit to IH-47 *South*.

Sign	*True*	*False*	*Sample Size*
G	25.84	74.16	329
H	24.07	75.93	324

5. Lane 2 traffic *must* continue on IH-16 West.

Sign	True	False	Sample Size ($p = .001$)
G	44.07	55.93	329
H	57.10	42.90	324

6. Lane 3 traffic *must* exit to IH-47 *North*.

Sign	True	False	Sample Size
G	85.41	14.59	329
H	84.57	15.43	324

Discussion of Results

Question 1 addressed the first objective. With only one up-arrow over Lane 3 (Sign H), 85.5 percent understood that the middle arrow referred to Lane 2 and that Lane 2 could not exit to IH-47 North. However, with two up-arrows (Sign G) 42.9 percent thought that Lane 2 traffic could exit. It is surmised that counting from the *right*, they assumed the second arrow referred to Lane 2.

Skipping to Question 5, drivers were asked if Lane 2 traffic must continue on the interstate. Only 57 percent of the responses to the Sign H group were the correct answer and even less (44 percent) of the responses to the Sign G group were correct.

Examining the elements of the sign provides several possible explanations for the poor performance. For the four-arrow group (Sign G), respondents may have assumed that both the second and third arrow referred to Lane 2. If so, traffic would have had an option to exit or continue and "must" continue was incorrect. This explanation would not apply to the three-arrow group (Sign H). The elements of both the sign and the question need be considered. The question gave only the route number (IH-16) and not the destination, "Hamburg," so the driver had to locate the small IH-16 shield. Another possibility is consistent with the findings of the first set of questions (Signs A, B, and C) in which a majority of drivers thought that the two routes displayed had separate exit lanes and the arrows accentuated this misinterpretation. Generalizing, some may have assumed that the second arrow referred to US-62 and the first arrow referred to IH-16. Regardless of the reason, performance was unexpectedly poor for both groups.

Questions 2, 3, and 4 all addressed the second objective. As expected, there was no significant difference in responses between the Sign G and H data because the issue of one or two right exit arrows did not apply to questions related to Lane 1.

When asked if Lane 1 traffic may continue on the interstate, over 40 percent answered negatively (Question 2). Evidently, respondents were not counting lanes from the left and identifying this as an optional usage lane. For Questions 3 and 4, understanding was much improved. Over 75 percent grasped the idea that Lane 1 had the option of exiting, but was not required to do so. It was somewhat paradoxical that they believed Lane 1 did not have to exit, yet 40 percent did not believe that Lane 1 traffic could continue either. Without fully answering this paradox, it is important to note the many misleading and confusing elements in this sign. First, the vertical lines suggest that the information in the middle part refers to Lane 2 only. Second, the optional usage arrow is over Lane 2 only. Third, the amount of information displayed is overloading. One must search to locate the small IH-16 interstate shield and read it. Also, single lane, left-side, optional exits may be less familiar to many drivers.

In summary, participants better understood that exiting was optional than that continuing was optional, suggesting many drivers may have been overwhelmed and confused by the formatting of the information.

The last question asked if Lane 3 traffic must exit to IH-47 North. About 85 percent of both groups answered correctly. Note that correct responses to Sign G were given equally by respondents who thought the third or fourth arrow applied to Lane 3.

Two concluding questions were asked. One question was, "Note that there are more arrows than lanes. Do you find this confusing?" The second question asked, "What do you think happened downstream that made this difference possible?"

Of 333 Set A respondents, 198 (60 percent) reported the four-arrow sign was confusing. To the write-in question about what was happening downstream, the responses were highly variable: 137 (41.1 percent) gave no answer; other responses were classified into three categories in the data analysis. The associated frequencies and percentages are as follows:

1. Partially correct—80 (24.0 percent),
2. Exactly correct—15 (4.5 percent), and
3. Ambiguous, irrelevant, or incorrect—101 (30.3 percent).

A partially correct tally was assigned for statements such as, "a lane was added on the right," "Lane 3 split into 2 lanes," "the road widens on the right," or words to this effect. Respondents grasped the notion of another lane but did not state that this lane had incoming traffic.

An exactly correct answer used verbs such as "merging, feeding in, or entering" to describe the new lane. A few stated there was a ramp or feeder road. Ambiguous responses were ones that indicated a possible lack of understanding. Irrelevant or incorrect comments included, "missed an exit," "it feeds to another road," "several forks leading to different highway," "road narrows," or mention of Lane 1 and 2. Some incorrectly said there was another exit upstream of the routes on the sign given; a few even mentioned a narrowing of the highway.

Less than 30 percent understood the meaning that four arrows indicated an added exit lane upstream on the right. And only 4.5 percent recognized that the lane would have traffic on it entering from a ramp. A majority felt it was confusing. Even those who did not report confusion were largely incorrect.

The display of more arrows than lanes in Sign G was confusing in terms of whether Lane 2 traffic could exit. Twenty-eight percent more were incorrect with four arrows as when there was one arrow per lane. An optional usage, a modified diagrammatic referring to Lane 1, failed to communicate that traffic in that lane could continue. Several explanations were offered. Failure to understand that Lane 2 could continue

with the three-arrow group was unexpected and may relate both to the question and the signing elements.

RESULTS FOR SIGNS I AND J

Objectives

The objectives of this comparison were as follows:

1. To determine if adding a guide sign over the fourth lane affected driver understanding of the Lane 3 and 4 exiting requirement [Sign I is the control group for Sign J in this comparison (Figure 5)], and
2. To determine the degree to which drivers misinterpreted Next Right as referring to a mandatory exit.

Questions Pertaining to Signs I and J

1. Lane 1 traffic *must* continue on US-83 South (US-79 South).

Sign	*True*	*False*	*Sample Size* ($p < .001$)
I	90.90	9.10	651
J	84.80	15.20	652

2. Lane 1 traffic may continue on US-83 South (US-79 South) or exit to IH-40 West (IH-60 West).

Sign	*True*	*False*	*Sample Size* ($p < .001$)
I	11.80	88.20	651
J	18.90	81.10	652

3. Lane 2 traffic *must* continue on US-83 South (US-79 South).

Sign	*True*	*False*	*Sample Size*
I	5.40	94.60	651
J	4.40	95.60	652

4. Lane 2 traffic may continue on US-83 South (US-79 South) or exit to IH-40 West (IH-60 West).

Sign	*True*	*False*	*Sample Size*
I	93.10	6.90	651
J	94.00	6.00	652

5. Lane 3 traffic *must* exit to IH-40 West (IH-60 West).

Sign	*True*	*False*	*Sample Size* ($p = .001$)
I	87.40	12.60	650
J	80.70	19.30	652

6. Lane 3 traffic may continue on US-83 South (US-79 *North*) or exit to IH-40 West (IH-60 West).

Sign	*True*	*False*	*Sample Size* ($p < .001$)
I	8.30	91.70	651
J	21.00	79.00	652

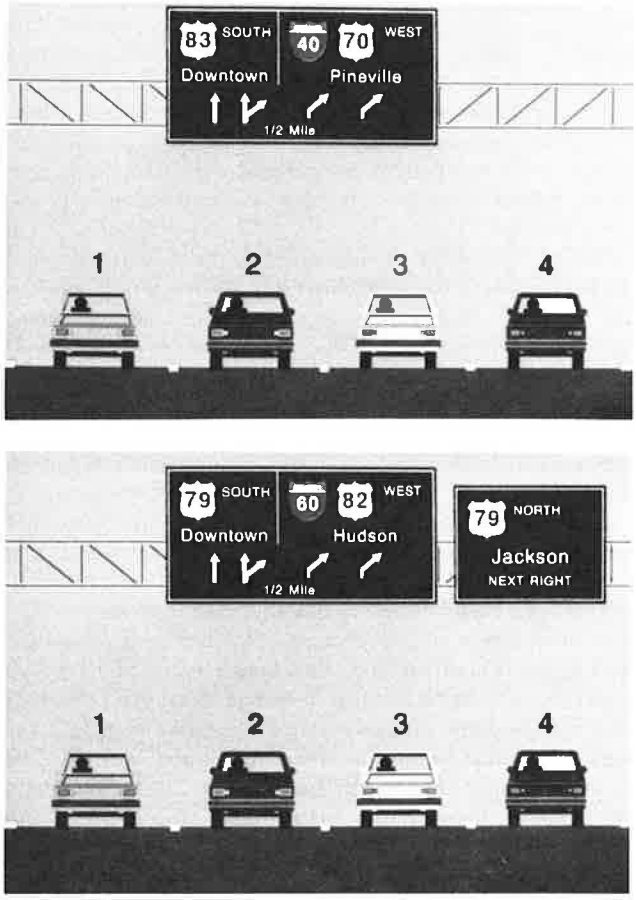

FIGURE 5 Signs I and J (*top* and *bottom*, respectively) were used to determine if a sign over Lane 4 changed comprehension of exiting requirements.

7. Lane 4 traffic *must* continue on US-79 North.

Sign	*True*	*False*	*Sample Size*
J	50.00	50.00	652

8. Lane 4 traffic may exit to US-79 North or may continue on IH-60 West.

Sign	*True*	*False*	*Sample Size*
J	44.40	55.60	651

Discussion of Results

The first two questions referred to Lane 1. Correct responses were high for both groups, but significantly higher for Sign I than Sign J. Regarding the optional usage lane, correct responses of both groups (trained and untrained) were in excess of 80 percent.

Regarding Lane 3, correct responses varied significantly (6.7 percent) between Signs I and J as to whether this lane must exit (Question 5). The guide sign in the right lane appeared to be exerting some effect on distinguishing lanes.

Because of editing errors it is not possible to compare the corollary question of whether or not Lane 3 is optional. For Sign I, 92 percent said that Lane 3 was optional (Question 6). However, Question 6 for Sign J listed the options as IH-60 West and US-79 North (rather than US-79 South). Thus, the correct response called for knowing a vehicle could negotiate into Lane 4 from Lane 3 and exit. The 79 percent correct is high, but it is not the same issue addressed in Question 6 for Sign I.

Questions 7 and 8 were asked for Sign J only and addressed Objective 2: understanding Next Right. Question 8 data are usable but Question 7 data are not because Question 7 used the word "continue" rather than "exit" for the exit to US-79 North. Compounding this problem, in the previous questions US-79 *South* was the continuing "downtown" route. Thus, if the reader did not see the cardinal direction (US-79 North) and translate "continue" as "exit," the question would be missed.

However, Question 8 was stated correctly, and 56 percent did not interpret Next Right as being optional. Recall that there was a similar although less pronounced misinterpretation of Next Left for Sign F, Question 1.

In summary, a large percentage of drivers misinterpreted Next Right as implying that Lane 4 must exit. The guide sign over Lane 4, particularly if it is viewed as an exit lane, may have exerted some influence over interpretation of the Lane 3 arrow, but had no impact on the Lane 1 and 2 arrows. The modified diagrammatics over Lanes 1 and 2 performed very well, possibly because they were simpler than those investigated in the previous questions.

SUMMARY AND CONCLUSIONS

A questionnaire, administered to a sample of volunteers at the Houston Auto Show, was designed to study several variables identified previously as being major sources of confusion in overhead guide signs. The lane assignment issues related to various signing elements, formatting of information, and overhead placement.

Previous survey research had identified high frequency problem areas. This research attempted to isolate the elements as potential contributors to misunderstanding and to measure understanding by a series of true-false questions. Questions referred systematically to each interstate lane and asked if traffic could exit from the lane, was required to exit, was required to continue on the freeway, or had a choice.

In general, the level of understanding was not as high as anticipated, particularly for signs that had been in use in Texas for many years (e.g., the white down arrow for optional usage and Next Left or Next Right messages). The large sample size and the demographics of the sample suggest that the findings are reliable. The volunteers were younger, better educated, and more experienced in freeway driving than the driving public in general. So if there was a measurement error, it would be in the direction of underestimating the true extent of misunderstanding.

One of the major findings of the study related to the conventional diagrammatic sign. Although previously suspected of having a shorter legibility distance compared to the modified separated lane arrows, the present study demonstrated that the conventional diagrammatic did not communicate lane assignment information as well, even when legibility was not an issue. Other major findings are as follows:

1. The downward white arrow on the left side of an exit sign was misinterpreted by 80 percent as an indicator that a lane has optional usage. A black down-arrow embedded in the Exit Only message did not improve understanding.
2. Moving the sign so that the downward white and black arrows are over the appropriate lanes did not improve understanding of the optional usage and, in fact, increased misunderstanding.
3. Two common routes appearing side by side on an exit guide sign misled many drivers to think that they referred to different routes to be accessed by different lanes. Adding the second black down-arrow accentuated this confusion. Arraying destinations under one another (Sign D) resulted in 85 percent responding that they were a common route.
4. The modified diagrammatic was 10 percent better than the conventional diagrammatic in indicating that the third (right-hand) lane must exit and was 13 percent better regarding an optional usage lane. The two were equally effective in connoting that the optional lane could continue.
5. A Next Left sign over a lane was misinterpreted by 30 percent as indicating a mandatory, single-lane exit.
6. When the number of arrow shafts on a modified diagrammatic exceeded the number of lanes displayed, drivers were confused about optional usage. When the number of arrow shafts equaled the number of lanes (Sign H) performance was 28.5 percent better regarding exiting from an optional usage lane. This suggests that the added lane downstream should not have been displayed on the advance sign.
7. When a modified diagrammatic was used to indicate an optional usage left-lane exit and when the arrow and other information was clustered over Lane 2, about 20 percent did not understand that Lane 1 traffic could exit and 25 percent thought traffic must exit. However, 45 percent thought traffic could continue. It is speculated that the location of the information overhead was misleading and that vertical lines accentuated the conclusion that the information did not apply to Lane 1. Too many secondary routes were displayed, forcing the reader to extract the small relevant route number from a mass of information. Diagrammatic signs need to be simplified to display only the primary routes.
8. On this same sign, misinterpretation that Lane 2 could continue on the interstate was unexpected; one explanation is in terms of the problem identified in Item 3 above. The high degree of understanding of the modified diagrammatic in Signs H and J suggests that it is not the diagrammatic itself but the array of information on the sign that may be leading to some confusion.
9. Next Right signs were misinterpreted by 56 percent of the respondents as mandatory exit. An improved message is required.
10. Although some data were lost because of miswording of two questions, some evidence supports the position that guide signs should not appear on the same bridge with a diagrammatic.
11. The effects of an educational paragraph on interpreting modified diagrammatics was not assessed because of poor conditions of administration. This issue remains unanswered.

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