Commentary Driving Applied to Safety Evaluation of Low-Volume Rural Roads: Training and Use

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ABSTRACT

The procedure of commentary driving is a simple field technique used in the safety evaluation of roadways. The procedure and its uses are described. A set of checksheets based on the concepts of decision sight distance are introduced. These checksheets should be a valuable tool in the safety evaluation of sites that are found to be information deficient by commentary driving. Two teaching methods for the technique of commentary driving were studied. The study was conducted to determine the amount of time required to teach someone the technique of commentary driving and then to determine the effectiveness of the two alternative teaching methods. The two teaching methods were to have the students make commentaries (a) while viewing a videotape of a predetermined route (VIDEO) or (b) while driving a predetermined route (DRIVE). It was concluded that the commentary driving technique and the use of the information-deficient location checksheets can be taught to county personnel in a 1- to 2-day workshop. It was also concluded that the VIDEO or DRIVE methods work about equally well in teaching the use of the commentary driving technique.

Every day, county personnel from states across the nation are faced with the problem of signing and maintaining the low-volume roads (roads with less than 400 vehicles per day) within their county. Many of the counties have their own methods for the inventory and inspection of their signs and markings. However, few counties have a simple method for the evaluation of information-deficient locations on their road systems.

Whereas an inventory is simply a matter of the number of signs and their respective locations, the inspection is concerned with the physical condition and appearance of the sign. An evaluation determines whether the current signs are correct, needed at all, or missing (i.e., an information-deficient location).

One can readily see that there is a definite need for some type of simple procedure by which the counties can evaluate the road systems for locations that are information deficient or potentially hazardous. Commentary driving is one such procedure. Commentary driving is a technique in which, at the beginning of a section of road to be evaluated, the driver states his expectancies of the road and as he proceeds along the road he comments on locations or conditions that violate his expectancy.

This study was conducted to determine the amount of time required to teach someone the technique of commentary driving and then to determine the effectiveness of two alternative teaching methods. The two teaching methods were to have the students make commentaries (a) while viewing a videotape of a predetermined route (VIDEO) or (b) while driving a predetermined route (DRIVE).

This study dealt only with the aspects of teaching the technique to county personnel in Kansas and to Kansas State University students who have the same background as the county personnel. The term "background" refers to the students' knowledge of the proper rules, regulations, general signing, and geometrical layout of county and township road systems. Even though, as described later in the Summary, commentary driving can be used for various other situations, this study was concerned only with its application on low-volume rural (LVR) roads. The reason for applying this limitation to the study was to gather information on teaching commentary driving to county personnel and to later add a section on commentary driving to the Handbook of Traffic Control Practices for Low Volume Rural Roads (LVR Handbook) (1).

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BACKGROUND

Commentary Driving Procedure

The information that a driver receives from the roadway must be correct, pertinent, concise, and presented in such a way that it is readily usable by the driver. In many cases, however, this information is not consistent with what he expects to, or should, receive. If the driver's expectancy of the roadway environment is violated, a potentially hazardous situation exists. The procedure of commentary driving was developed by R.S. Hostetter et al. (2). Generally stated, commentary driving is a simple field technique that requires no special equipment and from which information is gathered concerning the roadway environment to help eliminate all information-deficient locations. Information-deficient locations are specific locations on the roadway where the information, received by the driver from the roadway, is not sufficient to give the driver the needed information to safely traverse the roadway.

In the planning for the evaluation of a county's road system it is recommended that the roads be divided into several routes. Each route is from 3 to 15 mi long. Every road that the county is responsible for is placed on only one of the routes. The routes are listed on a priority basis so that the roads deemed to be most hazardous are evaluated first (2).

After the routes have been established and listed on a priority basis, either a team of two or an individual with a tape recorder (see section on personnel requirements) drives the roads, making sure to drive each route in both directions and, if necessary, driving some routes at night. As the team or individual drives the route, the driver will comment verbally on what information is needed versus what information is received from the various situations on the route. The driver's commentaries will usually be stored on a cassette tape so that later reference can be made to them if necessary.

The driver's commentary is divided into two parts. Within the first half-mile, the driver makes statements concerning the general nature of the roadway environment. Included in this group of general comments are the classification of the road, the surface quality, existing positive guidance (3), predicted safe driving speeds, availability of warning signs, and other general expectancies of the road. The driver's comments then focus more specifically on the events that he encounters as he moves farther along the roadway, commenting on the situations as they arise (2). The comments regard

1. The driver's expectancy concerning direction (i.e., straight or curves to the left or right), vertical curves, sharpness and safe speed of curves, oncoming traffic, culvert and bridge width and alignment, right-of-way controls at intersections, etc.;
2. What actions may be necessary regarding speed changes, lateral movement, turns, etc.; and
3. Any uncertainty related to any of the two foregoing items.

During the running commentary, the driver may believe it necessary to restate his initial comments. This is especially true on long straight tangents where there is little need for specific comments. It is believed that during the initial statement and restatement of expectancies, obvious information-deficient locations will be identified as a result of the commentary.

Verbal comments are suggested because this forces the driver to state what he expects from the road environment ahead and thus makes him more sensitive to any inconsistencies that may confront him. It is also suggested that the driver maintain a speed as close to the posted speed limit as is comfortably possible. If no speed limit is posted, the driver should drive the road as he believes a reasonably prudent driver would.

As stated earlier, the driver's comments should be stored on an audiotape cassette in a cassette tape recorder so the driver can replay the tape in the event that he must further investigate a site. For this reason, in addition to identifying the route, it is necessary that the driver record the mileage at the beginning of and also at the specific points of interest along the route. Although some drivers may be uneasy with the tape recorder at first, with a few hours of practice they will become relaxed and proficient in its use (2). This point is discussed in more detail in the Conclusions of this paper.

The last step in the procedure is to conduct more detailed surveys of the sites that have been identified as information deficient during the commentary driving portion of the task. This job is made easier by using the checksheets developed by Hostetter et al. (2,Vol.2). Figures 1 and 2 are 2 of the 10 checksheets. The other eight checksheets are for horizontal curves, tangential intersections, intersections that require a turn, railroad-highway grade crossings, uncontrolled Y-intersections, low water stream crossings, height and weight restrictions, and other situations. Table 1 is mentioned in Figures 1 and 2 and in the other eight checksheets. All of the checksheets were developed to aid the crew when they revisit the information-deficient locations to conduct further study of the site. The checksheets are self-explanatory for experienced highway personnel. The locations in question are those in which there was no obvious solution on the initial drive-through of the route. These locations can then be listed in priority order and later improved as the county acquires the funds for this purpose.

Survey Frequency

It is important to note that this type of survey probably need not be done at any set interval of time. In fact, once the initial survey has been finished, the only reason for redoing it would be for substantial changes in the nature of the roadway environment. This in no way means that once the survey is completed, the responsible county engineer is no longer concerned with providing the needed information to the motoring public. He must continue the routine inspection of all his roadways (2). Note that surveys during seasons of high vegetation growth can be very helpful in determining problems of obstruction of signs by weeds or trees.

Personnel Requirements

When a team of two is used, the driver does the commentary and the passenger acts as a guide or navigator. The passenger can also be a recorder if the tape recorder is not used. The main objective in using a team of two is to free the driver from concerns about staying on the route so he may concentrate on evaluating it.

Although there are no rigid requirements for selecting a driver, it is recommended that he be knowledgeable in the application of traffic control devices, particularly signs. He should also be familiar with the Manual of Uniform Traffic Control Devices (MUTCD) (4) and in particular the LVR Handbook (1). The preferred driver would be unfamiliar with the road system to be driven (i.e., an engineer borrowed from the neighboring county). The driver should be neither too cautious (overstates deficiencies) nor too aggressive (has high tolerance for deficiencies) (2).

Hostetter (2) suggests that the driver be a traffic engineer and the recorder be a technician. From their experience in Kansas, the authors believe that the driver (commentator) should be a county engineer or road supervisor or some other of the technical personnel experienced in the use of the LVR Handbook. Although it would be helpful if the passenger (navigator or recorder) were a technician, the authors do not believe this to be necessary. On the other hand, if the driver is a county engineer or road supervisor from, say, an adjacent county, the passenger should be a technically qualified person from the county in which the roads are located.

EXPERIMENTS

In this section the two experiments are described that were designed to answer the question, Can a student show that he has learned the technique of commentary driving by watching a videotape of a route in a classroom and commenting on what he sees, or does the student need to do the commentary from an automobile out on the road?

The commentaries were about 40 to 50 min long and the routes were 20 to 25 mi long for both experiments. All routes include examples of the various types (A, B, and C from LVR Handbook definitions) of LVR roads. Included in this section is a brief explanation of each experiment followed by a section on the statistical results.

Experiment 1

Procedure and Experimental Design

The 21 subjects for this experiment were all members of the fall semester 1984 Route Location and Design

ROUTE ID ______________ INTERSECTING ROUTE ______________

APPROACH DIRECTION N S E W (circle)

DATE ________ TIME ________ AM PM INSPECTOR ____________

SPEED LIMIT _____MPH ESTIMATED TYPICAL APPROACH SPEED ________MPH

DECISION SIGHT DISTANCE (circle one set)

SPEED (max of above)	30	35	40	45	50	55	60
DSD (feet)	220	275	345	420	500	585	680

(1) Is the intersection clearly visible from decision sight distance?
____Yes ____No

(2) Is the stop sign clearly visible from decision sight distance?
____Yes ____No

If no, go to (4)

(3) From decision sight distance, can you determine that the stop sign applies to you? ____Yes ____No

If yes, go to (6)

(4) Is there a STOP AHEAD warning sign present? ____Yes ____No

If no, go to (6)

(5a) Is the STOP AHEAD warning sign clearly visible on the approach?
____Yes ____No

(5b) Is the STOP AHEAD warning sign designed according to the specifications in the MUTCD? ____Yes ____No

(5c) Is the STOP AHEAD warning sign properly located? (i.e., neither too far upstream such that you would "forget" it or too close to the intersection such that you still would not have sufficient time to stop) (Check Table of Placement Distances for Advance Warning Signs)* ___Yes ___No

(6) Do other informational sources (i.e., roadway surface edges, terrain cuts, brush/tree line, shoulder edges, centerlines, etc.) provide information suggesting either 1) that the situation ahead is not a stop-controlled intersection, 2) that stop sign does not apply to your approach, or 3) that the stop controlled intersection is located further down stream than it actually is?
____Yes ____No

If yes, then identify those sources and describe how they provide confusing, conflicting or misleading information:________________

(7) Is the presently available information sufficient for you to recognize the stop-controlled intersection at a distance such that you can stop safely? ____Yes ____No

(8) Would the presently available information be sufficient for you to recognize that a stop-controlled intersection is located downstream:

- o during nighttime conditions? ____Yes ____No
- o when the roadside vegetation is at its densest growth? ____Yes ____No

* See Table 1

FIGURE 1 Information-deficiency evaluation checksheet for a stop-controlled intersection.

SUGGESTED TREATMENTS

____ Install STOP AHEAD warning sign
____ Improve visibility of STOP AHEAD warning sign
____ Relocate STOP AHEAD warning sign
-Move closer to intersection by ____feet
-Move back from intersection by ____feet
____ Replace non-standard warning sign with standard STOP AHEAD warning sign
____ Improve sight distance to intersection
____ Improve visibility of stop sign
____ Install stop lines
____ Improve markings at intersection
____ Improve signing at intersection
____ Correct for confusing, conflicting or misleading information:
____
____
____
____ Implement other treatment:
____
____
____

FIGURE 1 continued.

ROUTE ID____________________ LOCATION: ______________MILES FROM REFERENCE POINT__________________

APPROACH DIRECTION N S E W (circle)

DATE___________ TIME___________ AM PM INSPECTOR__________________

SPEED LIMIT_________MPH ESTIMATED TYPICAL APPROACH SPEED______________MPH

DECISION SIGHT DISTANCE (circle one set)

SPEED (max of above)	30	35	40	45	50	55	60
DSD (feet)	230	290	355	430	510	590	680

(1) Is the bridge clearly visible from decision sight distance?
____Yes ____No

If no, go to (3)

(2) From decision sight distance, can you perceive the reduced roadway width at the bridge? ____Yes ____No

If yes, go to (5)

(3) Is there a NARROW BRIDGE or ONE-LANE BRIDGE warning sign present?
____Yes ____No

If no, go to (5)

(4a) Is the warning sign accurate? (i.e., the ONE-LANE BRIDGE is applicable to bridges with usable roadway widths less than 16 feet or 18 feet if a significant number of wide vehicles cross the bridge or if the approach alignment is winding)
____Yes ____No

(4b) Is the warning sign clearly visible on the approach?
____Yes ____No

(4c) Is the warning sign properly designed according to the specifications in the MUTCD? ____Yes ____No

(4d) Is the warning sign properly located: (i.e., neither too far upstream such that you would "forget" it or too close to the bridge such that you still would not have sufficient time to select a safe speed and decelerate to it) (Check Table of Placement Distance for Advance Warning Signs)* ____Yes ____No

(4e) Is there a supplemental speed advisory plate attached to the warning sign? ____Yes ____No

* See Table 1

FIGURE 2 Information-deficiency evaluation checksheet for a narrow or one-lane bridge.

(5) Do other informational sources (i.e., hazard panels, guardrails, edgelines, roadway edges, bridge abutments, etc.) provide information suggesting 1) that the situation ahead is not a narrow/one-lane bridge, 2) that usable roadway width across the bridge is wider than it actually is, or 3) that a narrow/one-lane bridge is located further downstream?
_____Yes _____No

If yes, then identify those sources and describe how they provide confusing, conflicting or misleading information:____________________

(6) Is the sight distance to opposing vehicles sufficient for you to make a safe decision on whether you can safely cross the bridge and to safely execute the selected maneuver? _____Yes _____No

(7) Is the presently available information sufficient for you to recognize the narrow/one-lane bridge at a distance such that you can decelerate safely to a safe and comfortable crossing speed?
_____Yes _____No

(8) Would the presently available information be sufficient for you to recognize that a narrow/one-lane bridge is downstream:

- o during nighttime condition? _____Yes _____No
- o When the roadside vegetation is at its densest growth? _____Yes _____No

SUGGESTED TREATMENTS

_____ Install NARROW BRIDGE warning sign
_____ Install ONE-LANE BRIDGE warning sign
_____ Improve visibility of advance warning sign
_____ Relocate advance warning sign
-Move closer to bridge by _____feet
-Move back from bridge by _____feet
_____ Replace non-standard warning sign with standard warning sign
_____ Install supplemental speed advisory plate;
suggested speed is _____MPH
_____ Install other advance warning signs, i.e.,
_____ Curve warning
_____ Intersection warning
_____ Low overhead clearance
_____ Other (specify) ____________________
_____ Improve pavement markings at bridge (i.e., tapered approach treatment)
_____ Install hazard panels at bridge
_____ Improve visibility of bridge
_____ Correct for confusing, conflicting or misleading information:
_____ Implement other treatment:

FIGURE 2 continued.

class in the Civil Engineering Department at Kansas State University (KSU).

Before the subjects began the experiment, they attended several lectures and slide presentations in which they were given information on how to identify various types of problem locations. In addition, they were required to read the information and concepts presented in the LVR Handbook (1). Furthermore, they were exposed to the technique of commentary driving by way of prepared commentary driving tapes (videotaped segments of road with someone correctly doing commentary driving), and they were given handouts showing hypothetical examples of commentaries (2) (Figures 3 and 4).

The first group (pairs, driver and navigator) was assigned to go into the field and actually drive a designated route. While driving the route, the driver did commentary and identified the problem locations on an audiotape. The navigator simply made sure that the driver stayed on the designated route. Drivers were told that they would be graded on their ability to identify all of the problem locations on the route and to follow the recommended commentary driving procedure. They also were told that they would be penalized for reporting a location that was not actually a problem location. This was done to keep them from commenting that every little spot in the road was a problem location. The second group (individuals) was given the same assignment with the exception that they demonstrated their ability at

TABLE 1 A Guide for Advance Warning Sign Placement Distance[1] *(1,4)*

Posted or 85 percentile speed MPH	Condition A high judgment needed [3] (10 secs. PIEV)	Condition B—Stop condition	General warning signs[3] Condition C—Deceleration condition to listed advisory speed—MPH (or desired speed at condition)				
		0	10	20	30	40	50
20	[5] 175	(4)	(4)				
25	250	(4)	[2] 100				
30	325	[5] 100	150	[5] 100			
35	400	150	200	175			
40	475	225	275	250	[5] 175		
45	550	300	350	300	250		
50	625	375	425	400	325	[5] 225	
55	700	450	500	475	400	300	
60	775	550	575	550	500	400	[5] 300

Typical Signs for the Listed Conditions in Table II-1; Condition A—Merge. Right Lane Ends, etc; Condition B—Cross Road, Stop Ahead, Signal Ahead, Ped-Xing, etc.; Condition C—Turn, Curve, Divided Road, Hill, Dip, etc.

1 Distances shown are for level roadways. Corrections should be made for grades. If 48-inch signs are used, the legibility distance may be increased to 200 feet. This would allow reducing the above distance by 75 feet.

2 In urban areas, a supplementary plate underneath the warning sign should be used specifying the distance to the condition if there is an in-between intersection which might confuse the motorist.

3 Distance provides for 3-second PIEV, 125 feet Sign Legibility Distance, Braking Distance for Condition B and Comfortable Braking Distance for condition C as indicated in *A Policy on Geometric Design of Rural Highways,* 1965, AASHTO, Figure VII-15B.

4 No suggested minimum distance provided. At these speeds, sign location depends on physical conditions at site.

5 Feet

identifying problem locations by looking at a prerecorded videotape of the same designated route. Both groups were given a tape and tape recorder for recording their comments. At the end of the experiment, both groups returned their tapes.

Measurement

The experimenter evaluated the subjects' tapes by comparing them with a key tape (the experimenter's evaluation of the routes). The subjects were graded according to (a) the number of actual problem locations that they were able to identify and (b) the number of locations that they identified as problem locations when in fact they were not. A score was calculated for each subject by totaling the number of correct observations made and subtracting the number of incorrect observations made. The scores then were averaged for the subjects within the groups and the variances were found. The averages and variances then were compared for the two groups. The explanation of how the experimenter compared the subjects' tapes with his is given elsewhere (5).

Results

The tapes produced by the students were evaluated and a score was determined for each. The score was determined as described in the previous section. Table 2 shows the scores arranged in descending order and separated into the two conditions, VIDEO (commentaries made while viewing a videotape) and DRIVE (commentaries made while driving a selected route). The subject numbers have been arbitrarily defined and do not suggest the order in which the route was driven. The highest possible score for this route was 366 according to the experimenter's evaluation of the route.

Averages and standard deviations were calculated for both conditions. The average score for the viewers of the videotape (VIDEO) was 221 (range 189 to 257), whereas the average score for the students driving (DRIVE) was 175 (range 150 to 206). The

"Now travelling on Rt. 101, Northbound. The road has a smooth surface with a 2-4 foot paved shoulder and open terrain. The road is generally straight with a few gentle curves and short crests with generally good sight distance. The road is marked with centerline and edgeline. I expect to be able to travel at 55 mph even though a speed limit is not posted. I am not concerned about on-comming traffic. If there are curves or other situations requiring a speed reduction, I expect to be warned through appropriate signing."

or

"Now travelling on Jones Bridge Road, Southbound. The road is paved but there are occasional breaks in the pavement. There is no shoulder or centerline and I am not certain as to my lane limits. The road is curvilinear with several crests and dips which limit the sight distance. Except for some locations my safe speed is about 50 mph. There will be several occasions where I will have to reduce my speed but I expect to receive curve warning signs with speed advisory only at those locations."

FIGURE 3 Two hypothetical examples to show how one might comment on initial expectancies *(2).*

Item	Possible Commentary
	Example A
Approach to Crest	"Crest curve ahead, view of road limited . . . tree Vertical Curve line indicates that road goes straight ahead . . . not concerned about on-coming traffic . . . wide enough pavement . . . can maintain cruising speed . . ."
On Vertical Curve Crest	"Confirmed" [continue with next section] or "Expectation violated . . . tree line went straight but road curved left . . . not sharp enough to cause any problem . . . no need for warning sign." [continue with next section] or "Expectation violated . . . tree line went straight but road turned left sharply . . . needed to reduce speed . . . should have had curve warning sign at least . . . possibly speed advisory . . . mark site for study"
	Example B
Approach to Horizontal Curve	"Curve left ahead . . . see curve warning sign, no speed advisory . . . should be able to take curve at cruising speed . . . looking out for opposing vehicles because of narrow width"
Point of Curvature	"Curve sharper than anticipated . . . speed reduction necessary expecially if on-coming vehicles . . . mark site for speed advisory check"
	Example C
Approach to Narrow Bridge on Curve	"Curve right ahead . . . see curve warning sign . . . assume I can maintain speed . . ."
Closer to Curve/Bridge	"See bridge headwalls . . . narrower pavement . . . not certain if wide enough for two vehicles . . . need to slow down . . . can't see across bridge for opposing vehicles . . ."

FIGURE 4 Sample commentaries for specific situations *(2)*.

TABLE 2 Subject Scores by Subject

Condition and Subject	Score
VIDEO	
1	257
2	239
3	237
4	226
5	206
6	191
7	189
DRIVE	
8	206
9	203
10	175
11	168
12	168
13	159
14	150

standard deviation for the VIDEO condition was 26 as compared with 21 for the DRIVE condition.

The objective of the analysis of data by the F-test (6,pp.364-365) was to find out whether there was a significant difference between the two conditions of the experiment. Because the F-test assumes that the two samples are normally distributed, the two groups were checked for normality by using the Kolmogorov-Smirnov one-sample test (7,pp.47-52,251). The calculated D, the statistic for the Kolmogorov-Smirnov test, for the VIDEO condition was 0.16, whereas that for the DRIVE condition was 0.23. The critical D for both conditions ($N = 7$, $\alpha = 0.05$) was 0.49. Therefore, because both of the calculated values were less than the critical value, it was concluded that the sample could be assumed to be normally distributed.

Next, the F-test was run on the data set. The null hypothesis for this test was that the mean scores of the two conditions were equal ($H_0 : \mu_v = \mu_d$), where μ_v is the mean score of the VIDEO condition, and μ_d is the mean score of the DRIVE condition. The calculated F, the test statistic for the F-test, for this set of data was 12.64. The critical F for degrees of freedom $\nu_1 = 1$ and $\nu_2 = 12$ with an α-level, or probability of rejecting the null hypothesis when it is true, of 0.05 was 4.75. Because 12.64 is larger than 4.75, there is a significant difference between the two sample mean scores. In other words, the two sample sets probably do not come from the same distribution. Because the mean for the VIDEO condition was larger than that of the DRIVE condition, the subjects watching the videotape scored higher and performed better than those subjects driving the road.

Experiment 2

Procedure and Experimental Design

The second experiment was divided into two sections. The only difference between the two sections was the type of subjects used. The first section used 23 students from the spring semester 1985 Route Location and Design class at KSU. The second section enlisted the aid of 23 county-level highway employees (county personnel). Included in this group were county engineers, engineering technicians, road supervisors, bridge supervisors, signing foremen, and a Kansas Department of Transportation (KDOT) safety engineer. This section of the experiment was conducted as an experiment-workshop type of exercise. Two consecutive 6-hr days of instruction and experiment were used.

The subjects in each section were separated into two groups. The first group consisted of several pairs (driver and navigator), who were assigned to the DRIVE condition of the experiment. The second group consisted of the remaining individual subjects, who were assigned to the VIDEO condition.

Before the subjects began the experiment, they attended several lectures and slide presentations on how to identify various types of information-deficient locations. In addition, they were required to read the information and concepts presented in the LVR Handbook (1). Twenty-two of the 23 members of the county personnel had attended a 3-day workshop on the use of the LVR Handbook within the last 2 years. Furthermore, they were given instruction on the technique of commentary driving by way of lectures and prepared commentary driving tapes (videotaped segments of road with someone correctly doing commentary driving) along with handouts illustrating hypothetical examples of commentary for particular situations on a road (2) (see Figures 3 and 4).

Each section of the experiment consisted of two trials. In Trial 1, the first group (pairs, driver and navigator) was assigned to go into the field and actually drive a designated route. While driving the route, the driver did commentary and identified the problem locations and the navigator made sure the driver stayed on the designated route. Drivers were told that they would be graded on their ability to identify all the problem locations on the route and to make the correct and appropriate comments that described the route. The second group (individuals) was given the same assignment with the exception that they demonstrated their ability to identify problem locations by looking at a prerecorded videotape of the same designated route. Both groups were told that they would be penalized for reporting a location that was not actually a problem location, for the same reason as that in Experiment 1. At the end of Trial 1, the subjects in both groups returned their tapes to the experimenter.

During Trial 1 of the second section, the experimenter decided to see whether more than one person could participate in the VIDEO condition at one time. He found that by using full audio protection earmuffs, he could keep the subjects from hearing one another's comments. He also found that by using external microphones, held close to the subject's mouth, the comments from one subject did not record on the tapes of the other subjects. The subjects were spaced about 5 ft apart. In this part of the experiment only four subjects were trained at a time, but it is believed that more can be trained if room space and the field of view to the video monitor are available.

Before the start of Trial 2, the experimenter listened to portions of each subject's tape. From these tapes he was able to get a fairly good idea of how well the subjects were doing. Then the experimenter talked to the subjects about the types of comments that they had made and gave several suggestions that might improve their performance.

After the conference between subjects and experimenter, the subjects were sent out to the route for the second trial. In Trial 2, the assignment was similar to that given during the first trial. Once again the subjects were to use commentary driving to pick out the information-deficient locations on a route. The route was the reverse direction of travel of the route driven in Trial 1. As with the first trial, the driver-navigator pairs drove the route. For this trial, however, the individuals responsible for doing commentary while viewing the videotape of the route in the first trial became drivers (commentators) and went out with a navigator to drive the route. Navigators were either the experimenter or someone who had previously finished this part of the experiment.

Measurement

The experimenter evaluated each subject's tape for each route and compared it with a key tape (the experimenter's evaluation of the routes). The subjects were graded according to the same criteria listed in the Measurement section of Experiment 1. The score was calculated for each subject by totaling the number of correct observations made, subtracting the number of errant observations, and then dividing this by the total possible for each of the routes. This score reflects a subject's percentage of correct observations for a route and allows for the comparison of the performance of the participants in both directions around the route. The total possible score for the first route was 733 and for the second (reverse) route it was 798. An explanation of how the experimenter compared the subjects' tapes with his own is presented elsewhere (5).

Results

As described in the earlier paragraphs, the second experiment consisted of two sections. The first involved the use of students as subjects, whereas the second used county-level transportation personnel. In each section there were 23 subjects split into two groups, which reduced the amount of data collected even further. In an effort to make the tests more sensitive, the experimenter believed that the data should be combined in such a way that only two conditions were left; either the subject (student or county personnel) drove the route or else he watched a video of the route. In other words, both types of subjects were combined into one large sample within each condition.

The hypothesis for this test was that the scores for the two types of subjects, within conditions, were from the same distribution. It was assumed that the data sets were all normally distributed. The F-test was used to determine the statistic (6).

The first set of data that was analyzed was the Trial 1 scores for the VIDEO condition. The mean score for the students was 51.7 (range, 37.8 to 60.4), whereas that of the county personnel was 51.3 (range, 41.6 to 58.1). The standard deviations were 7.2 and 5.4, respectively. The calculated statistic, F, was 0.02. The critical F-value with degrees of freedom of $\nu_1 = 1$ and $\nu_2 = 14$ and at level $\alpha = 0.05$ was 4.60. Therefore, because 0.02 is less than 4.60, there is no significant difference between the two samples, and the samples could be from the same distribution.

TABLE 3 Subject Scores by Subject for the Combined Groups of Subjects

	Trial 1		Trial 2	
Subject	Condition	Score (%)	Condition	Score (%)
1	VIDEO	37.79	DRIVE	41.73
2	VIDEO	45.70	DRIVE	50.38
3	VIDEO	46.38	DRIVE	40.60
4	VIDEO	51.71	DRIVE	56.39
5	VIDEO	53.21	DRIVE	68.92
6	VIDEO	55.80	DRIVE	51.00
7	VIDEO	56.48	DRIVE	41.60
8	VIDEO	57.71	DRIVE	70.68
9	VIDEO	60.44	DRIVE	60.28
10	VIDEO	41.61	DRIVE	67.04
11	VIDEO	49.25	DRIVE	56.02
12	VIDEO	49.80	DRIVE	70.80
13	VIDEO	51.71	DRIVE	55.76
14	VIDEO	51.71	DRIVE	46.37
15	VIDEO	56.75	DRIVE	56.52
16	VIDEO	58.12	DRIVE	74.19
17	DRIVE	30.97	DRIVE	28.57
18	DRIVE	34.79	DRIVE	52.76
19	DRIVE	38.74	DRIVE	61.40
20	DRIVE	43.66	DRIVE	51.00
21	DRIVE	44.20	DRIVE	50.38
22	DRIVE	55.66	DRIVE	60.15
23	DRIVE	57.30	DRIVE	70.55
24	DRIVE	38.47	DRIVE	44.49
25	DRIVE	40.93	DRIVE	63.78
26	DRIVE	44.75	DRIVE	63.41
27	DRIVE	45.43	DRIVE	64.04
28	DRIVE	49.25	DRIVE	62.66
29	DRIVE	50.89	DRIVE	71.68
30	DRIVE	50.89	DRIVE	81.33
31	DRIVE	51.98	DRIVE	68.17

Next the sample sets from Trial 2 for the VIDEO condition were analyzed. The mean score for the students was 53.5 (range, 40.6 to 70.7), whereas the mean score of the county personnel was 61.0 (range, 46.4 to 74.2). The standard deviations were 11.5 and 9.9, respectively. The calculated F was 1.68, and the critical F was 4.60 with the same parameters just listed. Again there was no significant difference between the two samples, and the two data sets were combined.

The third data set to be analyzed was from the subjects in the DRIVE condition of Trial 1. The mean for the students was 43.6 (range, 31.0 to 57.3), and the mean for county personnel was 46.6 (range, 38.5 to 52.0). The standard deviations were 9.9 and 5.0, respectively. The calculated F-value was 0.55. The critical F with $\nu_1 = 1$ and $\nu_2 = 13$ at $\alpha = 0.05$ was 4.67. Once again the samples could be combined.

The last sample that was checked for the possibility of combining the two types of subjects was the Trial 2 scores for the DRIVE condition. The students' mean score was 53.7 (range, 28.6 to 70.5) as compared with that of the county personnel, which was 64.9 (range, 44.5 to 81.3). The respective standard deviations were 13.1 and 10.4. The critical F was 4.67. The calculated F was 3.44. Therefore there was no significant difference between the two samples.

Because there was no significant difference between the two groups of subjects as noted in the four cases just discussed, the experimenter combined the two groups. The remaining analysis of data is based on the two combined groups of subjects. Table 3 shows the reduction of the data due to the combination of subjects.

Before running the F-test (6) on the combined data sets, the experimenter checked the assumption of normality by using the Kolmogorov-Smirnov one-sample test (7). The four cases tested were Case 1: VIDEO condition, Trial 1; Case 2: VIDEO condition, Trial 2; Case 3: DRIVE condition, Trial 1; and Case 4: DRIVE condition, Trial 2. The calculated statistics were 0.0844, 0.1330, 0.0880, and 0.1160, respectively. The critical values were 0.328 for the VIDEO condition ($N = 16$, $\alpha = 0.05$), and 0.338 for the DRIVE condition ($N = 15$, $\alpha = 0.05$). Therefore, because all of the calculated values were less than the respective critical values, the results of this test show that the samples can be assumed to be normally distributed.

The first F-test, using the combined subjects, was run on the data taken from the tapes of Trial 1. The mean score of the VIDEO condition was 51.5 (range, 37.8 to 60.4) with a standard deviation of 6.3. In contrast, the mean score of the DRIVE condition was 45.2 (range, 31.0 to 57.3) with a standard deviation of 7.6. The calculated value of F was 6.43, which was greater than the critical F with degrees of freedom $\nu_1 = 1$ and $\nu_2 = 29$ and at α-level 0.05 of 4.18. Therefore there is a significant difference between the two conditions at $\alpha = 0.05$. This means that, on the average, the VIDEO subjects did a better job than did the DRIVE condition subjects.

The final F-test was run on the Trial 2 scores for the combined subjects. The objective for taking this set of data was to draw conclusions about which of the two methods better prepares the subject for the real-world environment.

The results of the F-test are as follows: The mean score for the VIDEO condition was 56.8 (range, 40.6 to 74.2) with a standard deviation of 11.1. In comparison, the mean score for the DRIVE condition was 59.7 (range, 28.6 to 81.3) with a standard deviation of 12.7. The critical F was 4.18 with the same parameters as were listed in the previous test. The calculated statistic F was 0.47. Because 0.47 is smaller than 4.18, there is not a significant difference between the two conditions. In other words, both methods equally prepare the student for the real world, that is, prepare him to identify problem locations on the actual roadway.

In both experiments the subjects' scores were low compared with the experimenter's evaluation of the route. The reason for this is that the experimenter wanted the tests to be as sensitive as possible. Therefore, as he listened to the tapes, he was looking for very specific comments that were not necessarily mandatory, but that could have been made if the commentator had thought about it at the time, for example, the location of every crest vertical curve, where power poles [positive guidance (3)] switch from one side of the road to another, whether the adjacent land is wooded or farm ground, and so on. These comments do not really impose a constant threat to the driver but they are a part of the roadway environment.

Although the scores were low, the experimenter believes that subjects did a satisfactory job of finding the really critical problem areas on the roads. The experimenter could go back and reanalyze the tapes without looking for the specific comments, but he believes that the time consumed would be wasted on a trivial matter. The experimenter is convinced that the subjects will be able to do an evaluation on LVR county roads that is complete and correct.

DISCUSSION OF RESULTS

The VIDEO condition can be looked at as a simulation of the real world while driving in the real world. The VIDEO condition also provides the opportunity to create real-life situations and combinations of situations that may not be readily found on the local roads but that may confront the student somewhere later. These situations can be set up and filmed and then removed so as not to pose a hazard to the drivers of the road. This allows for a multitude of "what-if" situations. The major drawback to this advantage is that it requires the road to be closed for the taping if the temporary situation is not a permanent feature of the road environment.

The instructor has no control over what the student in the field may miss when driving the roads. The instructor can, however, control what the student sees on the videotape. For example, assume that there is a sign, vital to the driver, with lettering too small to be read at the traveling speed or that is obscured by vegetation; the instructor can capture this sign on tape so that the student realizes that there is a problem at that location. Thus the student will be made aware that such situations do exist in the real world and will be able to find a corrective measure.

One major problem encountered in the DRIVE condition was the student driver's getting lost. This will always be a problem with the students learning by the DRIVE condition. Even with the navigator in the vehicle, the possibility of this problem exists. With videotapes of the route there is no possibility of the driver's getting lost. The VIDEO condition allows the driver to concentrate on the task of learning to do commentary driving and picking out the problem locations without losing his way.

The VIDEO condition allows for the training of people in remote counties that cannot afford to send someone to a central location for the needed training. The equipment is relatively lightweight and compact. The instructor, with considerable time, can locate various routes that have the same or familiar terrain as that found in the county that he will be visiting. He can then get these routes on videotape and take them to the county with him. Then as he trains personnel from other counties with similar terrain, he can use these same tapes. With the DRIVE condition the instructor would still have to go out several days in advance, locate routes to drive, and then put on the workshop, and if he needed to visit another county, he would to go that county and find even more routes instead of using the routes he had already found. The VIDEO condition is also independent of weather conditions present during the training period. If necessary, the videotapes can be used to train students at night who are normally too busy during the daytime hours.

The VIDEO condition can be used to train several people at the same time; therefore less valuable time is wasted than is necessary with the DRIVE condition. The multiple-person training session requires the use of full audio protection earmuffs and would be aided by the presence of more than one video monitor. The DRIVE condition requires a separate vehicle for each driver-commentator; therefore one must take into account the added expenses incurred.

CONCLUSIONS

Results of the Study

It can be concluded that students learn to do commentary driving equally well, if not better, by watching videotapes of routes than if they were sent out in an automobile to do the commentary while driving the same routes. It has been proven that a student will be able to do commentary driving in a real-world situation, driving the roads, even though he was trained to do the technique by watching a videotape of the route.

On the basis of the experience with Kansas county personnel in early 1986, the commentary driving technique and the use of information-deficient location checksheets can be taught in a 1-day workshop; a realistic schedule of activities for this workshop is as follows:

1. Introduction, purpose of workshop, and so on (0.5 hr);
2. Review of use of LVR Handbook (1.0 hr);
3. Introduction to commentary driving, examples, instructions for doing commentary driving from videotapes (1.0 hr);
4. Participants do commentaries and audiotapes from 30-min videotape (two video monitors, five participants per monitor, participants wear earplugs or muffs); 40 min per group of 10 participants should be allowed (2.0 hr);
5. Evaluation of commentary audiotapes by participants (students check the students) (1.0 hr);
6. Presentation, discussion, and instruction in the use of checksheets (0.5 hr); and
7. Feedback on participant commentaries (general observations on commentaries; meet with any individuals having particular problems with the technique) (1.0 to 2.0 hr).

This schedule assumes that the participants are experienced in the use of the LVR Handbook and that the number of participants is 30 or fewer. It has been found that the length of the videotape for commentaries could be reduced to about 30 min if various roadway sections or situations were carefully selected.

The most time-consuming part of the workshop was the evaluation of individual participant commentary tapes by the instructional staff and feedback to the participants. The evaluation could take about 10 to 15 hr of instructional staff time. In view of this problem, the students checked the other students, that is, participants (students) exchanged commentary audiotapes. Each participant then listened to the exchange audiotape and checked the accuracy of the commentary against a worksheet. The worksheet was prepared by the workshop instructional staff and contained, in sequential order, brief statements of the most important comments. It was found necessary to include the tape-counter number at regular intervals on the worksheet so the checker would not lose his place. This was necessary because the amount of commentary differed considerably among participants. The tape-counter number is a surrogate for the vehicle odometer reading used in specifically locating problem spots during commentary driving on the roads.

The scores from each worksheet for each participant were checked by the instructional staff. Each checker was asked whether he believed that the person whose audiotape he evaluated could do commentary driving. Each participant was also asked whether he believed that he could do commentary driving. For those persons with problems in doing commentary driving, the instructional staff gave additional instruction and answered individual questions.

Checksheet Evaluation

The checksheets (Figures 1 and 2) are based on the concept of decision sight distance (8,p.70;9). These checksheets were introduced to the group of county personnel in a workshop situation. They were asked to look over the checksheets and then give the instructors their opinion of how useful the sheets might be. The consensus was that the checksheets were ideally suited for suggesting treatments of sites found to be information deficient. The county personnel also agreed that the checksheets were easily followed and self-explanatory.

Use of Tape Recorders

It was found that only a short period of time was required by the subjects in both experiments to become relaxed while talking into the tape recorder. While listening to the tapes, the experimenter noticed that most of the subjects sounded awkward in their initial comments. After about 2 or 3 min, the subjects adjusted and there was a noticeable improvement in both the types of comments made and in the confidence and voice qualities with which these comments were made.

Summary

Commentary driving is a useful technique for highway personnel in the everyday safety evaluation of their projects. Although this paper has dealt only with its use on county low-volume roads in Kansas, it should be helpful in many other situations on higher-volume roads and highways. In particular, the technique could well be used at work-zone sites, school zones, and in the evaluation of signing and warnings at narrow or one-lane bridge sites.

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