Ability of Drivers to Make Critical Passing Judgments

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•ONE of the key skills required by the operator of a motor vehicle is the ability to make safe and accurate judgments required in the overtaking and passing of another vehicle. As pointed out by Lauer (2) "Every time one passes he must get on the wrong side of the road; he must face oncoming vehicles; and he must take chances in getting out and back into his lane of traffic."

Possibly one of the most critical elements involved in passing behavior is the ability of the driver of the overtaking vehicle to estimate what Forbes (1) has called clearance time. Forbes defined clearance time as the time allowed by the passing driver between the completion of his own pass and the arrival of the oncoming car abreast of him. The purpose of the present investigation was to determine how accurately drivers are able to estimate clearance time.

METHODS

Subjects

Nineteen male college students, whose ages ranged from 18 to 23 yr, were paid to participate in the study. All subjects had several years driving experience, and had served in previous laboratory investigations in which they had been screened for visual defects.

Procedures

Preliminary training.—A subject was picked up at his residence by one of the experimenters in the test vehicle (1959 Mercury). The subject immediately assumed control of the car with the experimenter sharing the front seat. Each subject was allowed approximately 15 min of familiarization driving to become acquainted with the characteristics of the car. This was conducted on a relatively traffic free road where the subject could accelerate, brake, etc., and, in general, become familiar with the vehicle. At the end of this period the subject was directed to a point where a rendezvous was made with an automobile operated by the second experimenter.

The second phase of the preliminary training took place on the site where the actual investigation was conducted. This was a section of S.D. 50, which is a moderately traveled state road constructed of concrete. The section consists of approximately 4 mi where long sight distances were available.

The subject followed about four car lengths behind the lead car which was maintained at 60/mph by the second experimenter. During this phase of preliminary training, the subject practiced passing the lead car. A subject was instructed to pass as rapidly as possible without endangering either vehicle. The experimenter obtained the time, in seconds, from the moment the subject began his pass (at which time the subject had been instructed to say "now") until he had completed the pass and was again in the proper lane of traffic. Each subject completed a number of practice passes before the beginning of the actual test session.

After completion of the preliminary training, both vehicles pulled over to the side of the road and the following instructions were read to the subject:

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> You will follow the lead car which will be traveling at 60 miles per hour. However, you will not pass it. Instead, when you see an approaching car you will estimate what you consider to be the last safe moment for passing the car ahead of you and let me know by saying "now." By safe, I mean allowing yourself enough time or "room" to pass without causing the oncoming car to reduce its speed or take any other precautionary measures. Your saying "now" is intended to indicate to me the amount of distance between your car and the approaching car that allows just enough room to pass safely. You should say "now" when you feel the distance between you and the approaching car has decreased to a distance just long enough for you to safely pass the lead car. Remember, do not actually attempt to pass—just say "now."

The instructions were repeated if the subject indicated that he was not clear on the procedure.

Test Condition.—The subject followed the lead car and each time another vehicle approached estimated what he considered to be the last safe instant for passing. When the subject indicated this by saying "now" the experimenter activated a timer. When the approaching car came abreast of the lead car, the experimenter stopped the timer. This period of time was considered as the subject's estimate of the minimum passing time or clearance time. This was repeated 10 times for each subject so that a total of 190 clearance estimates were obtained.

Clearance Time Estimates.—Each subject made 10 estimates of what he considered to be the minimum clearance time in which he could pass the lead car with sufficient time allowed so that an approaching car would not be forced to take any evasive action. For purposes of analysis, the mean passing time based on the practice passes completed in the preliminary training session was obtained for each subject. This was used as a correction factor and subtracted from each clearance time estimate made by the subject. For example, if a subject had made a clearance time estimate of 14 sec, i.e., 14 sec elapsed between the time he said "now" and the approaching car came abreast of the lead car, the mean passing time was subtracted from this figure. Thus if the mean passing time were 10 sec, the subject's clearance time estimate was considered as an overestimate of 4 sec. On the other hand, if his clearance time estimate was only 8 sec he had an underestimate of 2 sec.

RESULTS

TABLE 1

NUMBER OF UNDER AND OVERESTIMATIONS AND MAGNITUDE OF ERROR

Error (sec)	Under-estimates	Over-estimates
0 - .9	23	24
1.0-1.9	24	20
2.0-2.9	14	15
3.0-3.9	14	13
4.0-4.9	10	12
5.0-5.9	6	5
6.0-6.9	0	1
7.0-7.9	2	0
8.0-8.9	0	2
9.0-9.9	0	0
10.0 and over	0	5

Table 1 indicates the number of underestimates and overestimates made by the subjects and the magnitude, in seconds, of the estimates. The number of estimations in each of the two categories are quite similar and their distribution, in terms of magnitude of error, is likewise quite similar.

There was considerable variation among the subjects in their ability to make the required clearance time estimates (Table 2). Concerning the algebraic means of the individual subjects, each mean is based on the 10 estimates made by each subject with the mean passing time subtracted from the estimated clearance time previously described. Table 2 also gives the standard deviations as computed for the estimates of each subject, the ranges of the estimates, and the number of over and under estimates made by each subject.

TABLE 2

PERFORMANCE DATA OF INDIVIDUAL SUBJECTS

Subject	Mean	S. D.	Range		No. Estimates	
			High	Low	Under	Over
1	0.93	2.349	+4.70	-1.30	5	5
2	0.34	1.897	+4.17	-2.33	3	7
3	0.98	2.700	+4.80	-4.00	3	7
4	0.10	1.512	+2.84	-2.66	6	4
5	-3.01	1.840	-0.30	-5.40	10	0
6	-3.48	2.518	+1.70	-7.30	9	1
7	1.12	2.074	+4.20	-2.70	2	8
8	-0.59	1.569	+3.09	-2.51	7	3
9	1.83	3.180	+8.20	-3.30	3	7
10	3.55	2.847	+8.70	-1.30	2	8
11	2.58	1.866	+6.65	-0.15	1	9
12	8.15	5.667	+18.70	+0.70	0	10
13	-1.29	2.572	+3.50	-3.90	7	3
14	-2.39	1.311	+0.60	-4.10	9	1
15	0.79	1.873	+3.20	-2.30	4	6
16	-3.60	2.039	+0.40	-7.20	9	1
17	0.24	2.393	+4.20	-3.30	5	5
18	0.27	2.313	+4.00	-4.30	4	6
19	1.02	2.207	+5.70	-1.30	4	6

The results of this investigation can be considered from two points of view. If the investigation had been concerned with only the ability of an individual to deal with the various variables involved in the situation and to make a judgment of closure time based on his evaluation of these variables, it could be said that the subjects were capable of making this type judgment with a relatively high degree of accuracy. Thus the estimates, when plotted in terms of magnitude of error, form a normal distribution. With zero considered as a perfect judgment, under the conditions involved, 25 percent of the judgments fell within a ± 1-sec interval, and nearly 50 percent of the judgments fell within a ± 2-sec interval.

In viewing the results, however, the instructions to the subjects should be kept in mind. They were not asked to estimate closure time, rather they were instructed to estimate the last safe moment for passing the car ahead of them without causing the approaching vehicle to take any evasive action. In this context it would appear that many subjects are not capable of accurately making this judgment. Whereas an overestimate would be considered as a safe estimate, an underestimate would have resulted, in actual driving, in a situation where the subject would not have had time to pass the lead car. Nearly 50 percent of the judgments made were underestimates.

The nature of the investigation was such that subjects were required to make what might be termed critical judgments of clearance time. The primary concern in the study was with the ability of drivers to estimate as closely as possible the last safe moment for passing a vehicle with another car approaching. The typical driver is not frequently called on to make a decision of this type when operating a vehicle. However, the present investigation would suggest that when a judgment of this type is made, the average driver is not capable of making it with any degree of accuracy.

On the basis of timings taken by the experimenter, it was possible to determine whether the driver could actually have passed the lead car safely (overestimate) or whether he would not have had adequate time to complete the pass (underestimate). It

was found that out of a total of 190 estimates, 97 were overestimates and 93 were underestimates.

REFERENCES

1. Forbes, T. W. and Matson, T. M. Driver Judgments in Passing on the Highway. Journal of Psychol., Vol. 8, pp. 3-11, 1949.
2. Lauer, A. R. The Psychology of Driving. Charles C. Thomas, Publishers, Springfield, Ill., 1960.