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Abridgment

A Study of Route Selection from Highway Maps

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An experiment designed to assess the ability of subjects to plan long trips in unfamiliar areas by using only maps is described. The experiment was part of a larger study intended to describe and quantify the excess-travel problem in the United States. Subjects were asked to plan relatively long trips in unfamiliar areas by using only a road atlas. The sample was designed to represent the age and sex distribution of the U.S. driving population. The routes selected by the subjects were compared with the routes recommended by the American Automobile Association (postulated to be "optimum") for both distance and approximate driving time. Analyses of the data indicated that the excess distance of the routes selected by the subjects, on average, increased trip length by 12.1 percent. Age, sex, and geographic location of subjects had little effect on their performance.

Research *(1–3)* has shown that drivers face considerable difficulties in achieving optimum (i.e., in terms of minimum distance or time or both) routes from their origin to their destination. These travel inefficiencies have been shown to generate a considerable aggregate amount of excess travel.

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A comprehensive literature search *(4)* indicated that excess travel may be attributed to one or more of the following trip-making activities:

1. Use of route-selection criteria that do not lead to an optimum route;
2. Trip planning (i.e., application of criteria to route selection), including inadequate trip-planning skills or unavailable, insufficient, or inaccurate information for optimum trip planning;
3. Route following (i.e., implementation of a trip plan), including all aspects of response to, reliance on, and anticipation of highway information systems; and
4. Trip chain sequencing (i.e., ordering of multiple destinations in the absence of sequential or time constraints).

As part of a major FHWA-sponsored study *(5)* of the excess-travel problem and of potential remedial measures, a series of empirical studies of trip planning and route following were implemented. The procedures used and the results obtained for an experiment on trip planning for long trips in unfamiliar areas are described. The purpose of this experiment was to assess the

ability of drivers to plan trips in unfamiliar areas by using only maps and to estimate the amount of excess travel generated by trip-planning inefficiencies.

The experiment was implemented in two separate geographical locations that had previously been selected as the site for other investigations *(5)*:

- Western Fairfield County, Connecticut; and
- Western suburbs of Milwaukee, Wisconsin.

The subjects were recruited primarily through newspaper advertisements and were paid for their participation in the experiments. They represented the age and sex distribution of the U.S. driving population weighted for actual miles driven.

TEST PROCEDURES

Subjects were given the following instructions:

> You are to plan a route which minimizes both travel time and travel distance. You may use the atlas in front of you to determine your route. Record on the enclosed trip plan sheet the route number, direction of travel (e.g. North, South, East, West), the place where you get on the indicated route (from), the place where you get off the indicated route (destination), estimated travel time, estimated miles and estimated cost for car. Do not consider local travel within each of your origin cities to the route which you have outlined.

The atlas used was Rand McNally's *Road Atlas: United States—Canada—Mexico*. Subjects were under no time pressure.

Test routes were selected in accordance with the following criteria:

- Relatively long distance for each intermediate destination point or segment,
- Alternative routes possible,
- No direct Interstate route connection from origin to destination.

Route 1, which was given to all subjects, was San Antonio, Texas, to Shreveport, Louisiana, to Natchez, Mississippi, to Mobile, Alabama.

Route 2, which was given to all subjects in Wisconsin, was Norwalk, Connecticut, to Hershey, Pennsylvania, to Gettysburg, Pennsylvania, to Washington, D.C., to Norwalk, Connecticut.

Route 3, which was given to all subjects in Connecticut, was Milwaukee, Wisconsin, to Des Moines, Iowa, to St. Louis, Missouri, to Little Rock, Arkansas.

DATA REDUCTION

Data reduction consisted of determining, for each segment, the number of different routes used and the number of subjects selecting each route. Total distance, disaggregated by highway type, was determined for each route. These distances were converted into anticipated driving time by assigning representative speeds (using average U.S. values) to each link according to its highway type.

It is obvious that these average speeds do not represent, except for coincidence, the actual prevailing average route speeds on the specific highway links included in the various trip plans. However, these speeds can be considered those that may be anticipated, on the basis of highway classification only, by subjects unfamiliar with the routes. These speeds therefore approximate the inputs used by the subjects in making route-selection and distance-time trade-offs.

SUMMARY OF RESULTS

Preliminary analyses of the data indicated that there were no significant differences between Connecticut and Wisconsin subjects. All data were therefore merged and analyzed on an aggregate basis.

For 5 of the 10 segments, the minimum-distance route was also the minimum-time route. For one segment, the minimum-time route was only 1 mi longer than the minimum-distance route. For three other segments, the difference in anticipated travel time between the minimum-distance and minimum-time routes was 2 min or less.

The routes selected were compared with a "best route" as planned by the Connecticut Motor Club using normal American Automobile Association (AAA) route-planning procedures.

For four segments the AAA recommended the minimum-distance and minimum-time route; in two others the AAA selected a longer but faster route. It must be remembered that these comparisons are very sensitive to the assumed average travel speeds and that AAA probably has more accurate local travel time data.

All results obtained are summarized in Table 1. With the exception of one very short segment, the excess length of the planned route over the minimum route ranged from 6.8 to 19.7 percent for the entire sample and averaged 12.1 percent. The excess distance over AAA-recommended routes averaged 4.9 percent. The detailed discussion on selection of routes for individual segments has been presented elsewhere *(5)*. A paired *t*-test showed no significant difference due to subject sex.

Table 2 shows the distribution of routes selected. A number of different parameters indicating fractions of the sample selecting certain routes and the frequency with which routes were selected are shown. Examination of these data shows the following:

- For only 3 of the 10 segments did 50 percent or more of the sample select the minimum-distance route.
- For half of all the segments, 50 percent or more of all subjects selected a route that was more than 5 percent longer than the optimum.
- For 5 of the 10 segments, the modal route was also the minimum-distance route. For three of the other five segments, the modal route was a longer but all-Interstate route.
- Circuity of the route (i.e., the ratio of airline distance to minimum-route distance) did not correlate with any of the route-selection parameters shown.

For the 10 segments the excess-time over minimum-time routes varied from 0.6 to 17.0 percent and averaged 9.7 percent.

TABLE 1 SUMMARY OF RESULTS

			SEGMENTS									
			1	2	3	4	5	6	7	8	9	10	TOTAL
ALL	(a) TIME (HR., MIN.)												
	MALE	NUMBER	61	59	57	36	36	37	36	19	20	19	
		AVERAGE	7 25	3 55	4 33	4 2	0 53	1 35	4 47	6 58	7 12	6 16	
		STD.DEV	0 26	0 27	0 12	0 29	0 3	0 23	0 45	0 36	0 17	0 1	
		% OVER MIN	10.4	13.9	6.2	16.8	1.8	17.3	7.2	10.2	7.1	0.1	9.4
		% OVER AAA	6.7	-3.4	-3.2	18.5	1.8	17.3	7.2	2.9	8.7	0.1	4.2
	FEMALE	NUMBER	27	25	25	14	18	15	13	9	9	7	
		AVERAGE	7 34	3 55	4 33	4 4	0 53	1 28	5 0	7 1	7 17	6 24	
		STD.DEV	1 3	0 32	0 15	0 26	0 1	0 19	1 4	0 33	0 20	0 17	
		% OVER MIN	12.7	13.9	6.3	17.6	1.1	8.7	11.8	11.2	8.4	2.1	10.5
		% OVER AAA	9.0	-3.5	-3.1	19.4	1.1	8.7	11.8	3.8	10.1	2.1	5.2
	TOTAL	NUMBER	88	84	82	50	54	52	49	28	29	26	
		AVERAGE	7 28	3 55	4 33	4 2	0 53	1 33	4 51	6 59	7 13	6 18	
		STD.DEV	0 41	0 28	0 13	0 28	0 2	0 22	0 50	0 35	0 18	0 9	
		% OVER MIN	11.1	13.9	6.2	17.0	1.5	14.8	8.5	10.5	7.5	0.6	9.7
		% OVER AAA	7.4	-3.5	-3.2	18.8	1.5	14.8	8.5	3.2	9.1	0.6	4.5
ALL	(b) DISTANCE (MILES)												
	MALE	NUMBER	61	59	57	36	36	37	36	19	20	19	
		AVERAGE	421.2	215.8	245.2	230.3	49.4	87.6	271.1	404.1	408.8	365.4	
		STD.DEV	34.2	33.0	18.9	25.5	2.5	20.4	36.6	40.9	32.0	10.9	
		% OVER MIN	12.3	19.9	8.5	14.0	0.9	15.2	6.3	15.8	12.6	7.2	12.0
		% OVER AAA	12.0	-6.2	-8.2	16.9	0.9	13.7	6.3	7.7	16.8	-1.2	4.8
	FEMALE	NUMBER	27	25	25	14	18	15	13	9	9	7	
		AVERAGE	428.2	214.8	244.6	230.0	49.0	80.3	283.4	408.7	399.8	360.9	
		STD.DEV	64.9	36.5	20.2	26.2	0.	13.2	63.9	36.9	32.7	19.9	
		% OVER MIN	14.2	19.3	8.2	13.9	0.	5.7	11.1	17.1	10.1	5.8	12.4
		% OVER AAA	13.9	-6.6	-8.4	16.8	0.	4.3	11.1	9.0	14.2	-2.5	5.1
	TOTAL	NUMBER	88	84	82	50	54	52	49	28	29	26	
		AVERAGE	423.3	215.5	245.0	230.2	49.3	85.5	274.4	405.5	406.0	364.2	
		STD.DEV	45.5	33.9	19.2	25.4	2.0	18.9	45.0	39.0	31.9	13.6	
		% OVER MIN	12.9	19.7	8.4	14.0	0.6	12.5	7.6	16.2	11.8	6.8	12.1
		% OVER AAA	12.6	-6.3	-8.2	16.9	0.6	11.0	7.6	8.1	16.0	-1.6	4.9

TABLE 2 DISTRIBUTION BY ROUTES

		Percent Selecting					No. of Different Routes		Modal
Segment	*n*	AAA Route	Minimum Route	Minimum Route +5 Percent	Modal Route	No. of Different Routes	For 50 Percent of Sample	For 85 Percent of Sample	Route as Percent of Minimum
1	88	1.1	21.6	36.4	37.5	14	2	6	116.8
2	84	25.0	36.9	36.9	36.9	10	2	3	100.0
3	82	12.2	1.2	62.2	61.0	10	1	3	118.1
4	50	0.0	0.0	6.0	16.0	26	5	19	107.1/113.2
5	54	50.0	50.0	98.1	50.0	3	1	2	100.0
6	52	69.2	69.2	82.7	69.2	6	1	3	100.0
7	49	65.3	65.3	75.5	65.3	14	1	7	100.0
8	28	14.3	25.0	50.0	25.0	11	3	7	100.0
9	29	0.0	0.0	6.9	34.5	12	2	8	125.7
10	26	73.1	19.2	23.1	73.1	4	1	2	108.8

CONCLUSIONS

The data collected demonstrate that considerable excess travel occurs as a result of a driver's inability to plan trips by using maps as the primary source of information.

The data indicate that the contribution of trip-planning deficiencies to excess travel amounts to approximately 10 percent of vehicle miles of travel for the types of trips investigated. This figure is comparable with that obtained in empirical investigations of driver navigation performance for different trip types as part of this research *(6)* and during previous research efforts *(4)*. It is also comparable to, although somewhat lower than, the results obtained in previous research studies that used route mapping as the principal methodology *(7–9)*.

The significant effects of deficiencies in map-based trip planning indicate that concerted efforts to raise population skill levels in this area and to improve the clarity and legibility of maps used for that purpose may well be cost-effective.

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