Using an Interactive Route-Choice Simulator to Investigate Drivers' Compliance with Route Guidance Advice

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Possible sources of data on drivers' reactions to route guidance are discussed. Field evidence is sketchy and appears likely to remain so for some time. It is argued that an interactive route-choice simulator might provide acceptable substitute data. The design and development of such a simulator, interactive guidance on routes (IGOR), is described; users make a series of journeys through test networks by indicating their desired exit from each junction they reach. At each junction IGOR displays a plan giving information about road sizes and alignments, signposts, current traffic conditions, and so on. For some journeys the user has access to a map of the network, guidance advice, or both. The advice system replicates in-vehicle systems, which advise the driver what exit to take at each junction in order to minimize journey time in the current traffic conditions. To ascertain the effect of variations in the quality of guidance on user response, a "wrong" exit is sometimes recommended. The use of IGOR to collect data under the Dedicated Road Infrastructure for Vehicle Safety in Europe initiative is described and important results are presented. It is observed that acceptance of an item of advice depends on its (objective) quality, the quality of previously received advice, the drivers' knowledge of the network, and on the extent to which advice is corroborated by other evidence. Compliance with advice is a function of its credibility and this in turn depends on past experience, local conditions, and psychological factors. The value of IGOR and its results are discussed. Plans for use and further analysis of the IGOR data are outlined together with some options for further development of the concept.

In-vehicle route guidance (IVRG) or information systems are under development in various parts of the world and some have already been implemented, albeit on a limited scale. Examples include directional aids (Etak's Navigator); real-time traffic information transmissions (via car radios using the HAR ARI or RDS systems); real-time congestion displays (General Logistics' Trafficmaster); guidance based on historic data (Mercedes-Benz's, Routen-Rechner); and guidance based on real-time data (Siemens' Ali-Scout).

It is widely believed that such systems will be popular with car drivers and that they will influence route choice. Theoretical calculations have suggested that the net effect could be to increase network efficiency significantly by improving the efficiency of individual drivers' routes and, perhaps, by deliberately seeking to modify individual route choices in the interests of an overall network optimum. These calculations assume that equipped drivers will follow the guidance given.

Attitudinal surveys in the United Kingdom, France, and Germany (*1*) have, however, suggested that, particularly when driving on familiar routes, many drivers might be reluctant to accept guidance from a computer even if it did purport to "know" about current traffic conditions. There is clearly a potential credibility problem because many drivers believe that their own knowledge of the network would be superior to that of a computerized guidance system. To some extent, of course, the drivers may be right—for example, even if no deliberate attempt is being made to sacrifice individual benefits in the interests of a network optimum, the system may simply not "know" about potential short cuts through back streets and may be basing its guidance on information about traffic conditions received some minutes in arrears of what is actually happening on the streets.

An understanding of how drivers are likely in practice to react to route guidance or information is clearly crucial. Without it any estimates of the impact of such systems on network performance will be of purely theoretical interest and detailed work on the design aspects, such as multirouting guidance algorithms to avoid feedback problems, will be flawed. The problem, however, is that data on driver response to guidance and information systems is not readily available.

POSSIBLE SOURCES OF DATA ON DRIVER RESPONSE

A data set that would allow the exploration of the influence of the following would be ideal: (*a*) system variables such as quality of guidance received and completeness of the guidance network; (*b*) situational circumstances including current traffic conditions; and (*c*) driver characteristics such as age, sex, driving experience, and familiarity with the network. Ideally, again, data would be in sufficient volume to enable the calibration of quantitative models.

Direct observation of the behavior of drivers equipped with in-vehicle guidance, such as that used in Berlin's LISB project (an implementation of Ali-Scout), would seem to be an attractive potential source of data. It is theoretically possible, under LISB, to log the routes chosen by equipped drivers and to compare these with the routes used by those drivers before receiving guidance and with the routes which they were advised to use. With the cooperation of the SNV Consultancy, and with full permission of the drivers themselves, preliminary analyses of the LISB records were conducted by the University of Leeds during 1989. Unfortunately, however, the centrally held data on individual vehicles' routes proved to be unreliable and the "automatic" monitoring of individual driv-

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ers' response to guidance was found not to be a practical proposition. Another attempt to undertake automatic monitoring will be made in conjunction with the trial of the PATHFINDER route guidance system under California's PATH initiative.

Although automatic monitoring had proved to be impractical, the LISB trial was still an important potential source of data on driver response; in parallel with a much larger evaluation program being undertaken by the SNV consultancy, the University of Leeds was able to conduct a series of questionnaire surveys among LISB users (*2,3*). The questionnaires sought aggregate information on driver behavior (e.g., what proportion of drivers claimed to be seeking or following guidance in specified circumstances? What proportion have changed their routes as a result of guidance?) and attitudes (e.g., what reasons are quoted for not following advice?). The surveys yielded some valuable insights. Note for example that acceptance of advice was much lower on familiar journeys and that it declined over time. Among the most frequently quoted reasons for not following advice were that they thought it was sending them in the "wrong" direction and that they saw no reason to accept its advice to leave a normally good route, which had no obvious problems on the day in question. More complete results are quoted elsewhere (*4,5*).

Interesting and illuminating though these results from the LISB questionnaires may be, they do not provide the detailed data required for modeling purposes on issues such as the influence of the network specification, or the "accuracy" of guidance on driver response. This is primarily because they are subjective and aggregate rather than objective and disaggregate, but also because the LISB trial was designed primarily to prove the technology rather than to provide a test bed to explore such issues (*6*). Because there was no immediate prospect for such experimental designs being implemented in the field, or of disaggregate data being derived from them, it was necessary to consider the alternative methods of obtaining the needed data.

Because of the Institute's access to cars equipped with Ali-Scout, consideration was given to inviting "guinea-pig" drivers to exchange their own cars for ones equipped with Ali-Scout and then observing in what circumstances they did, or did not, follow the guidance received. Once again, however, it was concluded that it would not be possible by this means to explore all the variables of interest (particularly exposure to advice of differing qualities). It was also clear that cost and time considerations would limit the research to a vanishingly small sample of drivers.

Also considered was the use of relatively free-format interviews seeking attitudinal information from drivers who had been briefed, perhaps through a video, on the concept of route guidance. It was felt, however, that the resulting data would not have the precision required and that, because the issues had already been discussed in interviews in previous phases of our research, little new of substance would be learned.

The desiderata pointed to some form of stated-preference experiment wherein respondents would be offered a series of hypothetical route-choice decisions (with each option defined in terms of variables such as type of road, alignment relative to the destination, degree of congestion, whether it was the signposted route, and whether it was the advised route) and asked to indicate which option they would select. Such a technique could be administered using a conventional questionnaire or on an interactive computer (the advantages of which are discussed elsewhere) (*7,8*). On reflection however, no satisfactory way could be seen to build the quality of advice, or the drivers' previous experience of advice, into such an experiment. (Simply to tell respondents that the advice was right *n* times out of 100 would not suffice because it begs the question of how "right" is defined and how, in reality, a driver would perceive it.) It was this problem with conventional stated preference (SP) methods that led to developing the interactive simulator approach.

The value of interactive simulation as a means of gathering data on traveler response is increasingly recognized. Previous examples have included the Oxford work with HATS to study activity scheduling (*9*) and the Leeds use of multistage questionnaires to calibrate microsimulation models of car sharing schemes (*10*). Current interest has been stimulated by Mahmassani's work in Austin, Texas, on departure time choices and route-and-departure-time joint choices (*11–13*).

IGOR (interactive guidance on routes), a new model, provides drivers with feedback on the consequences of their own decisions but does not consider supply side response nor the consequences on other drivers—it is purely a device for gathering data on drivers' responses to the situations met.

INTERACTIVE SIMULATOR

Description of IGOR

IGOR runs on an IBM or compatible PC. Each user is invited to make a number of journeys through hypothetical networks by progressing from one junction to the next. At each junction, the participant is shown a plan of the junction, annotated with contextual information (see Figure 1 for a typical screen), and is invited to press a key to indicate the chosen direction. The participant is, on some of the journeys, provided with route guidance advice (in the form of a flashing arrow on the advised direction) but is free to ignore it if desired.

Each user makes several journeys from specified origins to specified destinations. For some journeys, a hard-copy map of the network is provided, for others, no map is provided. The conditions faced and the decision made at each junction are logged for subsequent analysis—thereby enabling the determination of the circumstances in which guidance is accepted or rejected. To examine the effect of the quality of advice on its acceptability, IGOR is programmed to provide a given amount of "bad" advice to participants. Some participants get better advice than others (the quality of advice received by each participant at each junction is known).

The current version of IGOR was developed over a 6-month period from late 1989 and has a number of features that should perhaps be described in greater detail.

Network

A hypothetical network containing 30 two-way links and 19 nodes has been the basis of the work. (See Figure 2 for a copy of the network map provided to users.) This network represents a typical small town with a historic center and a bypass

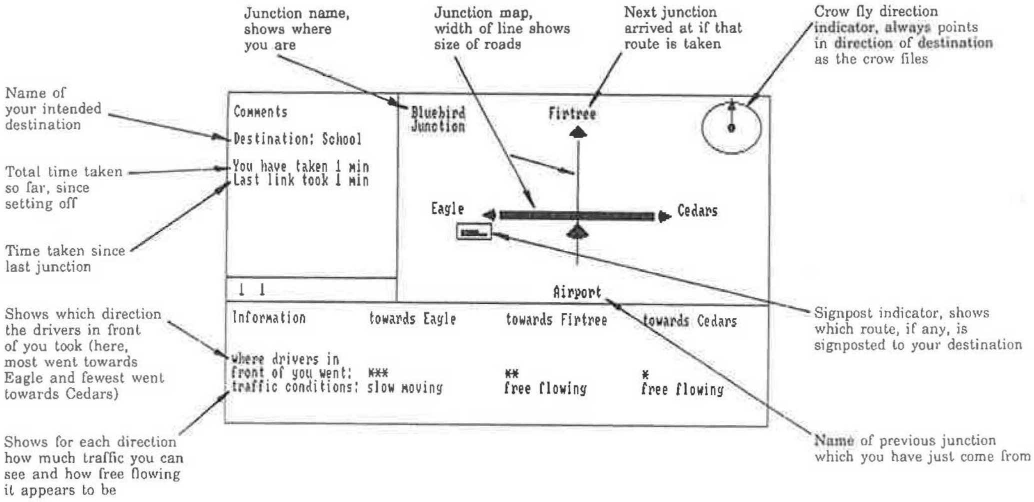

FIGURE 1 Annotated copy of IGOR's on-screen display.

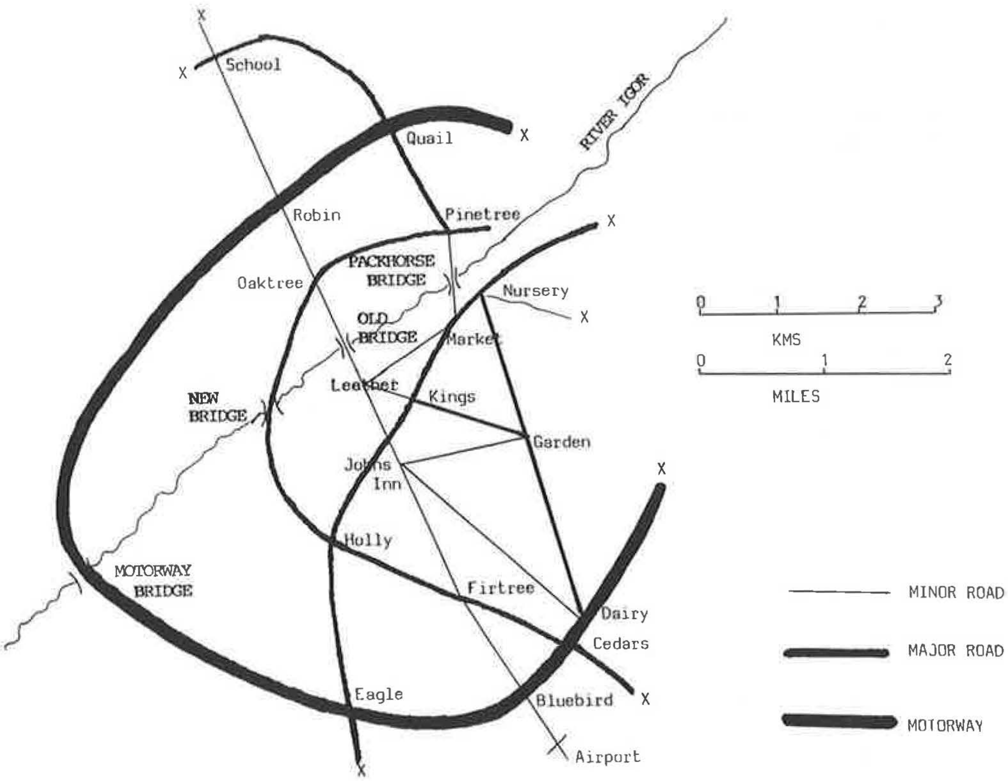

FIGURE 2 Map of network provided to IGOR users.

and has been designed to offer a number of interesting route-choice options. The junctions have been named thematically to introduce some sense of route identity.

Each link has a basic length but its traverse time during a particular journey depends on the supposed time of day and weather conditions and on a random element to represent day-on-day variability; thus the level of congestion varies from one journey to another to a degree that is realistic without being predictable.

IGOR can accept different network data and could, for example, represent one way streets or limited access junctions. There is no reason in principle why the network description should not be tailored to represent a real network with which the participant would be familiar. This option will be experimented with in due course.

Guidance System

The guidance system is currently programmed to produce the minimum time route to the specified destination given the current conditions. However, as is the case with real guidance systems such as Autoguide or LISB, IGOR's guidance system is "unaware" of some of the links in the network. This fact, together with the deliberate provision on some occasions of "bad" advice, ensures that the advised route is not always the quickest. This fact was not drawn to the attention of users.

On-Screen Display

Figure 1 shows a typical display during a journey. It reminds the participants of their destination, how long it has taken so far, and how long the last link took. The junction plan is aligned such that the entry arm is at the bottom. All the exits are labeled, to show which junction they lead to. The road type (highway, main street, or side street) is indicated by the width of the exit arm. The general crow-fly direction to the destination is indicated by an arrow (this is a proxy for the driver's general sense of direction). If it is desirable to indicate that the destination is signposted from the current junction, then the signpost symbol appears next to the appropriate exit arm. If guidance advice is being given, then the appropriate exit arm arrow will flash.

Traffic information is summarized in a table under the junction plan. It indicates what might be seen from the junction—thus, it indicates how much, if any, congestion can be seen on each exit link, and which exits are being chosen by drivers supposedly in front of the participant. (This information is included because previous research had suggested that drivers might be influenced, in their choice of exit arm, by what other drivers seemed to be doing.)

Other information that is displayed at specific junctions includes progress confirmation information such as "you have just entered the city center" or "you have just crossed the river." To provide some feedback, the driver is given, at the beginning of each journey, an estimate of the probable journey time assuming average travel conditions at that time of day and, at the end of each journey, the driver reminded of this estimate and told how long the trip actually took.

Sound Generation

In the current version of IGOR an engine sound is emitted as the driver moves from one junction to the next. The duration of the sound is proportional to the time required to traverse the link and its pitch is proportional to the speed. Thus the driver gets an impression of the passage of time and of the travel conditions—a high gear sound would accompany a trip round in uncongested ring road while a series of short low gear sounds would accompany a trip through the congested city center.

Interactive Questionnaires

As background for analysis of participants' decisions, information is required about their personal characteristics and attitudes. When participants first log on, they are asked to provide a certain amount of personal information (age, sex, home location, car ownership, access to company car, distance driven per year, whether they drive to work, whether they drive in the course of work, and how adept they consider themselves to be at finding new destinations for the first time). Also, before each journey, IGOR asks whether users already have an idea of which route they intend to take and if so, which bridge they intend to cross—this question is carefully phrased to minimize the possibility that they might subsequently feel committed to that route but does, it is thought, invite users to do a certain amount of strategic planning such as is often done in practice. The intention is to experiment with the inclusion and exclusion of this question in due course.

After completing their last journey, participants are presented with 6 SP questions in which they have to indicate which of two directions they would take in each of the 6 specified situations. The situations are designed such that in the first one the guidance system is in conflict with all other evidence, in the second it is in conflict with everything except the compass direction and so on, for each of the 5 variables. After these SP questions have been answered, players are asked some attitudinal questions: had they previously heard of in-car route guidance? (If so) had they expected to be useful to them? Had IGOR caused them to change their opinion for the better or worse? In what circumstances, or combinations or circumstances, would they, in real life, reject guidance? What criteria do they usually use in selecting routes in various situations?

Storage of Results for Subsequent Analysis

In designing IGOR facilitation of the analysis of the data was sought. Data for each participant is stored in a file with a unique identifier to record the time and data of the session. Each file contains a record for each decision made by the participant. Each record contains the participant's personal characteristics and answers to the attitudinal questions along with the description of the situation faced at the junction, information about the quality of advice received at this, and previous, junctions, and the decision actually made. The data is thus ready for analysis without any need for extensive file editing. The only data that needs to be brought in from a separate source are those relating to the conditions under which IGOR was used (i.e., whether any survey staff were present—and if so, who? And how the participant was "recruited"?). There is no reason in principle why this data too should not be typed into the PC and automatically entered into the files.

This description of the IGOR model summarizes one contained in a previous paper (*14*), which also includes more details of potential further developments of the concept.

Organization of an IGOR Session

There are, of course, many ways in which an IGOR session might be organized. The program will run on a portable PC and so can be used in peoples' homes or workplaces or at airports or transit stations much as one would a conventional questionnaire.

A typical session will have the following components:

1. Introduction—explanation of how to use IGOR;
2. Characteristics—questions on personal characteristics;
3. Familiarization—3 journeys without guidance designed

to familiarize the user with IGOR and the network (a map of the network is provided);

4. Description of guidance—introduction to the concept of in-car guidance; explanation that the guidance is based on current traffic conditions;

5. Reaction to guidance—6 journeys with guidance (using the network introduced in phase 3) and 3 journeys with guidance in a different network (no map provided), these represent unfamiliar journeys;

6. SP exercise—6 stated preference questions; and

7. Attitudes—direct questions on the perceived usefulness of guidance and on the user's normal route choice criteria.

All seven phases can be carried out through the PC screen and keyboard and could, in theory, be conducted without any survey staff in attendance. Indeed it would be possible to send out a disk containing the program to people with access to a PC for them to use it at their own convenience and then mail back the disk containing the data.

RESULTS OF AN ANGLO-FRENCH IMPLEMENTATION OF IGOR

Data Collection and Analysis

As part of a project under the European DRIVE initiative, IGOR has been used on behalf of the CARGOES consortium to collect information on drivers' reactions to route-guidance advice. A French translation of the on-screen information enabled French partners, INRETS, to use IGOR in Paris while it was being used in various locations in the United Kingdom. Some 350 participants were recruited, mainly through their employers, and most sessions took place at the participants' workplaces during early summer 1990. An analysis of participants' characteristics shows them to have been fairly representative of the car driving population.

Each participant made several journeys and each journey consisted of several decisions. The resulting data base contains data on more than 11,000 decisions. Further details of the data and its analysis can be found in the project report (*4*).

The IGOR data base has proved to be a very rich source of information, the analysis of which is by no means complete. It is, however, appropriate to present here those results relating to the subject of the current paper—drivers' acceptance or rejection of route-guidance advice.

Results

General

Analysis of the IGOR data base shows that, overall, about 70 percent of advice was accepted. The current analysis seeks to determine the extent to which acceptance or rejection is a function of objectively defined characteristics of the advice or of the decision makers.

Acceptance of Advice as a Function of Quality

As has been mentioned previously, unknown to the participants, the quality of advice given by IGOR was deliberately varied. The relationship between acceptance of an item of advice and its quality (defined as the minimum time to reach the destination by means of the advised route divided by the minimum time to reach it by any route) was examined. Plots of acceptance versus quality as shown in Figure 3. The x-axis in Figure 3(a) is an index of quality based on travel times in the IGOR network as they were at the time the journey was actually made, whereas the x-axis in Figure 3(b) is an index of quality based on free-flow travel conditions.

Both plots show that acceptance declines as the quality of advice decreases. It is clear that, although they were not in-

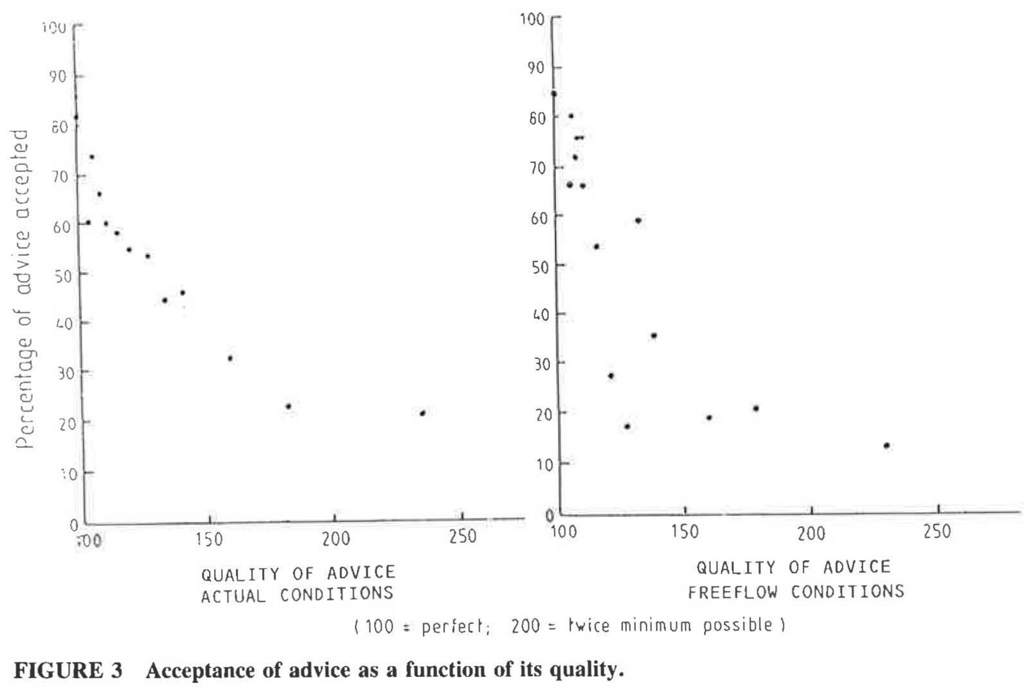

FIGURE 3 Acceptance of advice as a function of its quality.

formed that the quality of advice was variable, participants appear to have detected the fact and acted accordingly. The decline in acceptance is particularly sharp as the index of quality falls from about 100 (perfect advice) to about 150 (advised route half as long again as the best possible route). This initial decline is particularly strong in Figure 3(b), suggesting perhaps that participants' perception of the usefulness of advice was strongly conditioned by the physical layout of the network. This question will be revisited later in the paper.

Regression curves were fitted to the data shown in Figure 3 and the resulting equations were

$$p = 1.89 - 0.01q + 3.14qa^2 \qquad (r^2 = 0.94) \qquad (1)$$

$$p = 6.37 - 0.95qf + 0.00qf^2 + 8.2qf^3 \qquad (r^2 = 0.80) \qquad (2)$$

where

p = probability of acceptance,
qa = index of quality based on actual travel times,
qf = index of quality based on free-flow travel times, and
r^2 = squared correlation coefficient (fit of curve with data).

The poorer fit for the equation based on free-flow travel times may reflect the fact that some journeys were made in networks for which no map was available and of which the participant could not therefore be expected to have a good image of physical layout. This hypothesis will be pursued in further tests.

A third definition of quality, based not on the ratio of times via the advised and the true best route, but on the absolute difference between their times, was calculated and acceptance of advice was plotted against it. A relationship was apparent but the fit was not good.

Acceptance as a Function of Quality of Previous Advice

Acceptance of less than perfect advice by an individual seemed to depend not only on the quality of advice in question but also on the quality of advice previously received by that individual. Figure 4 shows that if previous advice had, on average, been very good, then even a very poor piece of advice was likely to be accepted, but if the quality of previous advice had, on average, been bad then a very poor item of advice was almost certain to be rejected.

Apparently participants who had become accustomed to receiving good advice became less critical of the occasional bad piece of advice, either because they did not feel it necessary to question it or because they were inclined to give it the benefit of the doubt. On the other hand, participants who have been experiencing a lot of bad advice seemed to treat any advice with great skepticism.

Further analysis, not reproduced here, suggests that the average quality of the most recently received items of advice was particularly influential in establishing the credibility, or otherwise, of the current advice. The data was also examined to see if any primacy effect existed—whether the quality of the first few items of advice was particularly important. No such effect was apparent.

Acceptance as a Function of Familiarity with the Network

Acceptance of advice generally decreased as familiarity with the network increased. Table 1 shows that, among people who had been receiving fairly reliable advice, it fell in a decreasing curve, dropping by about 10 percent between the first and second journey in a given network, by about 50 percent between the second and third journey, by about 2 percent between the third and fourth, and by about 1 percent per journey thereafter. The decline in acceptance among people who had been receiving poor advice was much less regular and appeared to be very dependent on actual conditions met.

Acceptance was highest when a new destination had to be found in a new network for which no map was available; in such circumstances even those who had been receiving very poor advice had little option but to rely on it. Acceptance was lowest when a journey was being made in a network for

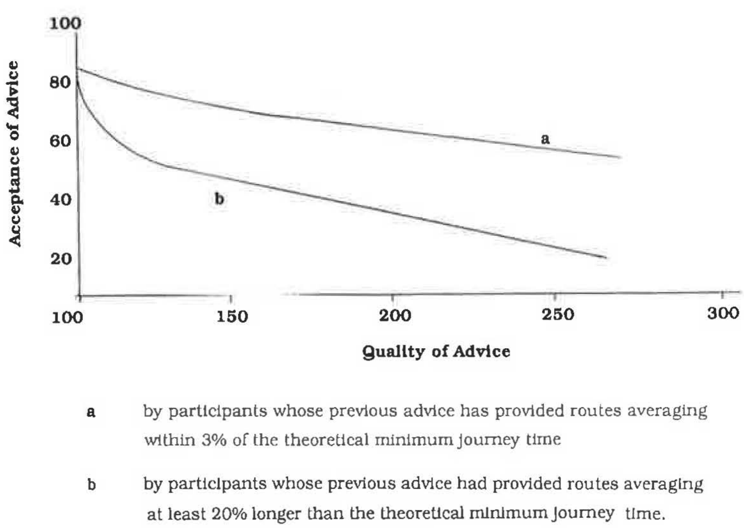

FIGURE 4 Acceptance of advice as a function of the quality of previously received advice.

TABLE 1 ACCEPTANCE OF ADVICE AS A FUNCTION OF FAMILIARITY WITH THE NETWORK

Journey Nº	Nº of previous journeys in this network	Nº of previous visits to this destination	Map available	% of advice accepted a	b	c
4	3	2	Y	79	24	72
5	4	3	Y	77	56	70
6	5	1	Y	85	56	69
7	6	4	Y	76	59	67
8	7	5	Y	75	65	68
9	8	2	Y	81	58	68
10	0	0	N	96	79	83
11	1	1	N	84	73	77
12	2	0	N	89	74	76

a when previous advice had provided routes averaging within 3% of the theoretical minimum journey time

b when previous advice had provided routes averaging at least 20% longer than the theoretical minimum journey time

c for all qualities of previous advice.

Source: DRIVE V1011 tests with IGOR in UK and France

which a map was available, to a destination that had been visited several times before.

Although acceptance of advice declined with increasing familiarity, participants' adherence to preplanned routes increased as their confidence grew.

The Effect on Acceptance of Corroborating or Contradictory Evidence

The influence of circumstantial evidence that tended to corroborate or contradict the advice was studied in some detail. The results reported in Table 2 show that some features—particularly the alignment of the advised exit relative to the crow-fly direction to the destination, the behavior of other drivers, and the presence or absence of congestion—had a significant impact.

The impact was particularly strong when the advice itself was not optimal (i.e., when the advised exit was not the one that would have got participants most quickly to their destinations). Thus, if non-optimal advice happened to be in the right direction (in terms of compass bearing) it was accepted by 74 percent of participants but if it was in completely the wrong direction it was accepted by only 22 percent of participants. Similarly, if the non-optimally advised exit happened to be used by most other drivers, then the advice was accepted by 67 percent of participants, but if it was the least used exit by other drivers it was accepted by only 30 percent of participants. The visible presence of traffic congestion on all exits other than the advised one, or of a road sign apparently confirming the advice, also has an important effect on the acceptance of non-optimal advice.

Acceptance of optimal advice was not influenced by corroborating or contradictory evidence to quite the same extent as was acceptance of non-optimal advice. Even so, the effect of compass direction, visible congestion, and the behavior of other drivers was very important.

TABLE 2 ACCEPTANCE OF ADVICE AS A FUNCTION OF THE EXTENT OF CORROBORATION OR CONFLICT FROM OTHER SOURCES OF INFORMATION

Source of corroboration or conflict	% of Optimal advice accepted with: (a) Max corrob-oration	(b) Max conflict	% of Non optimal advice accepted with: (a) Max corrob-oration	(b) Max conflict
Crowfly direction indicator	91	56	74	22
Other drivers' decisions	85	76	67	30
Traffic congestion visible on exits	90	74	58	44
Signposts	80	80	59	42
Size of road	80	80	49	52

Source: DRIVE V1011 tests with IGOR in UK

It appears reasonable to conclude from the evidence presented in Table 2 that participants' reaction to advice was strongly conditioned by local network conditions and their perception of the physical layout of the network. To the extent that these are correlated with optimal advice, this no doubt explains how the acceptance comes to be so closely related to the quality of guidance.

The SP exercise conducted with each participant immediately after their last journey with IGOR allowed the further exploration of the effect of corroborating and contradictory evidence on acceptance and rejection of advice.

The SP results were similar to those from the main IGOR exercise, in as much as they showed the importance of congestion and of the crow-fly alignment and the relative unimportance of road size and signposting, but there was some evidence that the fixed ordering of questions in the SP experiment had influenced the results. Problems such as this frequently occur in conventional questionnaires but are avoided in the main IGOR exercise because the order and content of situations faced by participants vary from participant to participant and from journey to journey.

Acceptance of Advice as a Function of Personal Characteristics

There was some relationship between participants' apparent propensity to accept route-guidance advice and their personal characteristics. In many cases, however, the relationship was not significant at the 5 percent level and in some cases quite different relationships were apparent in the British and French samples. Among those relationships that were significant at the 5 percent level in the British sample, women were found less likely to accept advice, particularly non-optimal advice, than men (38 percent compared with 46 percent of non-optimal advice was accepted, respectively) and people who have a high annual kilometrage or who regularly drive to work were less likely to accept advice than others. It was also noted that acceptance of advice, particularly non-optimal advice, was highest amongst people who quoted distance minimization as their main criterion for route choice (71 percent of non-optimal advice accepted compared with 47 percent for the whole sample). Also, those who said they had previously heard of route guidance, and had thought it likely to be useful to them for most of their journeys, accepted advice more readily than the population at large (52 percent compared with 47 percent).

DISCUSSION OF RESULTS

Practicality of the Tool

Experience with IGOR in the United Kingdom and France has confirmed the expectation that it would provide a cost-effective method of collecting large amounts of data. The management and control of the surveys, the handling of the data, and the speed of subsequent data processing have all proved very satisfactory (though not fool proof—almost 10 percent of the data set was lost because of a disk error on the French machine).

IGOR appears to have been popular with participants and no difficulties were experienced either with recruitment or with people wishing to terminate a session part way through (the average session lasted about 35 to 40 min and respondent fatigue might have been expected to set in had it been a conventional questionnaire or interview).

Although IGOR is self-contained and could in theory be run without any survey staff in attendance, in practice it was found useful to have someone present to record any comments made by the participant at any stage during the session and to seek more attitudinal information from them at the end of the session. Comments made by participants while they were deciding which exit to take proved very revealing as to participants' decision processes and are perhaps a valuable source of data in their own right.

The idea of mailing IGOR disks to people with access to their own PC's had little success because of the current concern about the importation of computer viruses by means of direct-mail disks.

Reliability of the Results

IGOR puts the participants in a simulated route-choice situation and provides them with simulated guidance but neither of these is the real thing. Participants do not receive real environmental stimuli and do not work within the same constraints as they would were they making real journies. The stimuli could be improved albeit at the cost of reduced portability, by use of more sophisticated graphics or simulators, such as is being done by research teams interested in the ergonomic aspects of IVRG (*15–18*) but even so, the situation would still be artificial.

Having conducted some 350 IGOR sessions, followed by debriefing sessions with each of the participants, there is confidence that they understood what they were doing and were interpreting the on-screen information (such as that relating to the decisions of other drivers and the disposition of signposts) realistically. There are, however, two reservations; one relates to the crow-fly direction indicator and the other to the way in which feedback on performance was given.

The crow-fly indicator was supposed to represent the drivers' general sense of direction and it probably fulfilled this task quite well for journeys made in a familiar network or with a map. However, given that only a minority of drivers carry directional compasses in their vehicles, it may be that it was unrealistically precise for the journeys being made in an unknown network without a map. If this is so it will probably have depressed the acceptance of advice on such journeys lower than what it might otherwise be; the consequence of which would be that the acceptance would be even more sensitive to familiarity than the results suggest. In future versions of IGOR, the intention is to experiment with less precise direction indicators and, for some journeys, with having no direction indicator at all.

At the end of each journey participants were reminded of how long they might have expected the journey to take and informed of how long they actually did take. This information was intended to give them some fairly realistic feedback on their performance. There is, however, some evidence, particularly from among the French participants, that the information was treated as a score and may have encouraged some participants to seek minimum time routes to a greater extent than they would do in real life (only 35 percent of French participants quoted time minimization as their overriding criteria for route choice on the journey to work). If this is so it may have caused the relationships between acceptance of an item of advice and its (objective) quality to be stronger than they might otherwise be. In future versions of IGOR other forms of feedback will be experienced with, including measures tailored to an individual participant's stated route-choice criteria.

The analysis suggested that personal characteristics generally had influence on an individual's acceptance of advice and the authors are confident that, with the possible exception of the points outlined above, the results are probably a fairly good indicator of how people might react to route guidance in real life. It would, of course, be nice to be able to confirm this by comparing IGOR's results with observations from real schemes. The problem, of course, is that there is insufficient evidence from real schemes against which to judge the IGOR results (indeed had such evidence existed, IGOR would not have been necessary). The IGOR results are, however, consistent with those obtained from attitude surveys among drivers equipped with Ali-Scout equipment in Berlin's LISB system (*2,3*). More rigorous tests of the IGOR results must await the availability of large volumes of data on individual drivers' responses such as might be obtained by automatic monitoring of vehicle movements as part of a carefully designed field trial.

Until such evidence becomes available, IGOR is surely one of the best sources of quantified data on which to base models of drivers' response to route-guidance advice. It is certainly to be preferred to stated intentions, preferences, and attitudes derived by more conventional means.

Further Work

Unless equipped drivers form only a trivial proportion of the driving population, their behavior, whether or not it is in compliance with advice, could materially affect network conditions. A realistic model of route guidance or information systems must incorporate a representation of mechanisms on the demand-side as well as on the supply-side. Much might be gained by embedding the calibrated models of driver response, derived from IGOR, within one of the network simulation modeling frameworks currently being used to examine driver information systems (*19–24*).

IGOR has proved to be a very valuable tool with which to examine route choice. It has already enabled experiments with a range of situations that cannot readily be observed in the field. A natural progression appears to be to use it to study a range of route-choice issues and to represent a variety of driver information systems. Plans are underway to represent systems that provide text or map-display information as well as, or instead of, guidance.

The process of developing IGOR itself highlighted a number of interesting issues relating to route-choice behavior—for example the role of feedback on performance, the role of pretrip planning, and the accuracy of individuals' knowledge of their orientation. We intend to examine these and other issues in future versions of IGOR (*25*).

Analysis of the data collected in Britain and France during 1990, and of comments by participants and survey staff, has raised important issues, some of which will benefit from further analysis of the existing dataset, whereas others will require further experimentation. Further analysis will, it is thought, throw more light on the way in which different factors (e.g., qualities of guidance and corroborating evidence of various kinds) act in combination to influence acceptance of advice, whereas exploration of participants' motivations will require further experimentation.

The use of IGOR in Britain and France during 1990 was supported under the DRIVE initiative in order to assist in the prediction of the extent to which drivers will accept route-guidance advice. Plans are underway, as part of an SERC sponsored project at the Universities of Leeds, Southampton and York, to generalize the program, to look more broadly at route choice and network learning behavior. It is hoped that IGOR will be able to produce data to support the specification of more general route-choice models in which guidance is merely one of several potential explanatory variables.

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