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# TRAVEL TIME VARIABILITY OF A GROUP OF CAR COMMUTERS IN NORTH LONDON

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**ABSTRACT**

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This working paper describes a study of the variability of journey times of a panel of fifteen commuters using one north London radial corridor, over a total of seven weeks in the spring and summer of 1987. The objectives were to gain preliminary information on the extent of journey time variability and on the commuters' perception of and responses to the variability they experienced. The procedure for selecting the panel and contacting them is described, together with the data collection method, which consisted principally of panellists using tape recorders in their cars to record the time at which fixed points along the route were passed on each day's journey to work. Early or late arrival and its consequences in relation to the dya's tasks were recorded at the destination. Analyses are presented of the distributions of times of complete and partial journeys, of the relationship between journey duration and variability and of the effects of diversion in response to perceived traffic conditions. The safety margins needed to ensure given percentages of punctual arrivals were estimated and contrasted with those from previous studies. Further analyses are presented indicating the general unimportance of punctuality for these panellists, the effects of significant lateness when it did occur, and of the panellists' ability to predict their arrival times in advance. A study of highway link travel time variability and its causes was also carried out for cars at the same time in the same corridor. The methodology, surveys and data processing of this parallel study are set out in ITS Working Paper 278, and the results and analysis in ITS Working Paper 279.

**Travel time variability of a group of car commuters in North London.**

1. Introduction

1.1 Objectives

This working paper is one of three describing a study of travel time variability experienced by car drivers on the A41 radial route in North London, carried out in the spring and summer of 1987.

The objectives of the complete study were:

i. to produce an estimate of the amount of variability of travel time for car travellers both within short time periods and between time periods, including different days;
ii to estimate the importance of variability to car users;
iii to attempt to explain the observed variability;
iv if the variability could be satisfactorily explained in a general model, to use and/or adapt an existing traffic network model to simulate travel time variability and thus investigate the potential effects on it of traffic engineering and transport planning measures;
v if variability was found to be of major importance, to develop proposals for the research necessary to investigate user perception of and response to variability more fully.

To achieve these objectives, the study was designed to have two distinct and self-contained parts. One part (the "engineering study") was concerned with measuring variability on links of the A41 and explaining it in terms of the traffic characteristics of the links. The other part (the "panel study") was concerned with recording the day-to-day travel time variability experienced by a selected group ("panel") of regular car commuters, both for their entire door-to-door journey and for sections within it. The ability of panellists to predict their journey times and the consequences of the variability they experienced were also recorded. This part of the work was designed to help fulfil objective (i) and to fulfil objectives (iii) and (v).

This working paper represents the methodology and results of the panel study. Two other working papers describe the engineering study: one dealing with the methodology and surveys (May et al, 1989a) and the other with the results (May et al, 1989b).

1.2 Scope and limitation of the study

It was considered best to undertake the engineering and panel surveys based on the same route(s). Consideration was given to carrying out the study in London or in Leeds, or both. Resources did not allow routes in both cities to be investigated in enough detail, so London was chosen as work on travel times on urban radial routes in Leeds had been undertaken by the Institute for Transport Studies in 1982 (May and Montgomery, 1984). Further work on the travel times of car commuters in Leeds, is reported in Robertson (1987).

Since the overall study was concerned with car commuters, a radial route was chosen. The criteria for selection were mainly related to the requirements of the engineering study and are (within seconds, if one did not already exist) two surveyors (in the case of Baker Street which had 3 lanes) and one surveyor (on Lisson Grove which had 2 lanes) entered the stream and distributed the cards as described. Ten seconds before the end of the red period, the surveyor on the pavement blew a whistle, giving those in the traffic sufficient time to retreat to safety. The Baker Street location was particularly suitable for this type of survey as it had a 3-lane stop line with the pavement on one side and a central traffic island on the other, giving protection for the surveyors. The cycle time was also long with a red period on the main A41 flow of rather less than a minute.

Though randomisation was not a prime consideration, an attempt was made to ensure that postcards were more or less equally distributed between cars in the various traffic lanes. When traffic was heavy (for most of the survey period) each surveyor would take a single lane in each signal cycle, selecting a particular car to start with, and then always continuing to the <u>next</u> car in the queue, to remove any unconscious selection process on the part of the surveyor. Before the main peak, perhaps for the first 20 minutes after distribution started at 0730, it was noticeable that almost all cars coming down the A41 at the Baker Street site were not being stopped by the red, but were going straight through on the linking of the traffic signals. During this period, those few stopped by the red signal tended to be those joining the A41 from drives and side streets immediately upstream of the junction. During this period, postcards were not given to these cars. Most of the postcards at both sites were given out between the time traffic became heavy (0745) and 1015, when the postcards were exhausted; the majority from 0745 to 0930.

No problems were encountered at either site. Almost all those approached accepted the postcard graciously. The survey proceeded quite safely, though more care had to be taken at Lisson Grove because of the lack of a central traffic island. At both sites large notices were displayed about 50 metres upstream of the stopline, warning that a census was in progress. Instructions for survey personnel are given in Appendix 1.

The postal questionnaire used is shown in Appendix 2.

The ten questions were designed to determine the suitability of the respondent for a place in the panel, in terms of how frequently he or she drove to work through the A41 corridor, how often they detoured, at what time they travelled and how well they knew the route. The final question asked the respondents to give name, address and telephone number if they were willing to take part in the panel survey, which was explained in outline in the explanatory section of the postcard.

Of the 500 postcards handed out, 130 were finally returned. The returns were screened to identify those who:

- usually drove to work;
- made a detour either less than once a week or every day;
- passed the point where the postcard was received

Circular* (for longer journeys) then the Exit from Swiss Cottage Gyratory* on the A41, then the junction of Park Road and Baker Street* and the final car park (at the moment of switching off the engine). For longer journeys, one or more mutually-agreed points were often inserted, north or south of the North Circular Road (e.g. joining M1). Eight points were the maximum used, including origin and destination. The agreed points were listed and numbered during the telephone conversation. The panellists were asked if they had any questions on the instructions, and were exhorted to read them in full if they had not already done so. They were told that they would receive their tape recorder, digital clock, tapes, accompanying survey forms and final instructions (see below) by 12th March 1987 in time to try out the method in a pilot survey on their journey to work on Friday 13th March.

2.3 Survey equipment

The parcel was in some cases sent to the panellist's home and sometimes to the place of work, according to what was preferred. Parcels sent to a workplace were marked 'traffic survey equipment only', for the information of office security personnel.

Each parcel contained:

Cassette recorder (in box with original packing) containing one tape (named) and labelled '1' (for the first week), ready to record on side A. New batteries had already been placed in the recorder.

Microphone

Empty case for cassette in use

Three blank cassettes numbered 2 to 4 (for each survey week). The person's name was on side A of each cassette and each was dated according to the corresponding week.

Digital clock set to correct time. (The watch was about the size of a credit card and just less than 1cm thick. It showed hours, minutes and seconds).

Two sticky pads, to fix clock to a suitable place in the car, for easy viewing.

Four small padded envelopes, each with a business reply label affixed, addressed to the Institute for Transport Studies (to return tape each week to ITS). Also a spare business reply sticker, so the equipment could be returned to ITS in its original packing.

* or equivalent locations if parallel routes were used.

tape recorder to give sufficient information about the points on the detour for the route later to be traced. When (if) the normal route was rejoined, the location and time was recorded, and subsequent points recorded in the normal way. Stops other than those due to traffic were also recorded - both duration and reason (e.g. buying petrol, picking up a passenger). Unusual conditions which appeared to be affecting the journey were often also recorded, whether or not they provoked a diversion.

At the destination car park, the panellist recorded the time at which the engine was switched off, and the name of the car park (and location if not the regular place) was given. Any final observations about the journey just completed were added at this stage. The recorder was then switched off for the day (the work-to-home journey was not recorded) using the 'stop' switch on the recorder itself.

On arrival at work, the panellist recorded the time at which he or she arrived at the desk. This was recorded to the nearest minute, as the digital watch was normally still in the car. Panellists were, however, encouraged to set their own watches to agree with the digital watch. The arrival time was recorded on the 'daily arrival record' form. On this form, the respondent also recorded, on a five point scale from 'unnecessarily early' to 'seriously late', how early or late they perceived themselves to be in relation to their work on that day. Finally, they recorded one or more consequences of their early, late or punctual arrival on that day.

This procedure was repeated on every week day on which the respondent travelled to work. Days missed, for example because of a meeting in another city, were marked on the 'daily arrival form' and some respondents put in extra days' recording to compensate for this.

At the end of each week, the tape and the daily arrival form for that week was returned in a reply-paid padded envelope to ITS, and the tape and the form for the next week were prepared. At the end of the survey, the recorder and clock were also returned, unless the panellist chose to keep the recorder in lieu of payment.

Before the main survey began, all respondents tested the method on Friday 13th March. There were several telephone calls after this, concerning the equipment, but in all cases these problems were sorted out on the telephone.

## 2.5 The summer survey

In the summer of 1987, all remaining members of the panel were again contacted, with a view to repeating the work with as many of the original panel as possible. In the event, only 6 of the original panel were able or willing to take part at the specified time. Of these, two were women and the rest men. The remainder were unable or unwilling to participate for a number of reasons, by far the most common being absence, due usually to holidays. The survey in the summer was repeated by these six people in exactly the same way as in the spring, the only differences being journey time predictability and the extent and travel time effects of changes in route. In the analysis, comparisons are also made between the main spring survey and the smaller summer survey. Initial analysis of the spring data was carried out by Robertson (1987).

The basic data for the survey consisted of 276 journeys in the spring, and 89 in the summer. Before analysis, it was necessary to eliminate some data from these totals. Firstly, journeys outside the peak period were removed. Two of these occurred in the spring and none in the summer. Non-peak journeys were defined as those exiting the Swiss Cottage Gyratory system before 0715 and after 0945.

A treatment for diverted journeys was required. In analyses relating to times on route sections, including those comparing the times of several panellists, diversions via non-common route sections were eliminated. In analyses relating to complete journeys, journeys with diversions made as a result of traffic conditions encountered on the route were retained, while those journeys including diversions for non-traffic reasons (taking a passenger to a railway station off the usual route, for example) were eliminated. Journeys with non-traffic stops where the stop-time was unrecorded were eliminated. This included one occasion in the summer when a panellist was involved in a minor accident. All journeys to a different destination from normal were also dropped from these analyses, though this was rare. Analyses of whole route travel times do not therefore imply the route taken by individual drivers was always exactly the same.

In the summer survey, two panellists used a non-direct route in order to pick up a passenger on the way. One of these people did this on all survey days and recorded the exact time spent waiting for the passenger. These journeys were included, with the waiting time subtracted. The other person picked up the passenger on five out of fifteen journeys and used a direct route on the other occasions. As the time spent waiting was not recorded, the journeys on which the passenger was picked up were eliminated from the analyses, but the direct route journeys retained.

Rerouteing to avoid perceived traffic delays (i.e. routeing away from the originally specified route) occurred on 25 (about 9 per cent) of the journeys analysed in the spring, but on only 3 journeys (4%) in the summer.

## 3.2 Variability by route section, by panel member.

The means, standard deviations and coefficients of variation of travel time were calculated, by panel member, for whole routes and for route sections. The coefficient of variation is a particularly useful measure as it allows comparisons of variability between sections. With the exception of the panellist in the summer who sometimes picked up a passenger, the routes and the section timing points were the same for the smaller group of summer panellists as they had been in the previous spring.

**Table 1: Variability for individual panellists**

| | Spring | | | Summer | | |
|---|---|---|---|---|---|---|
| | Coefficient of variation | | | Coefficient of variation | | |
| Person | Whole Journey* | Inner London | Sample Size | Whole Journey* | Inner London | Sample Size |
| 1 | – | 0.10 | 12 | | | |
| 2 | 0.13 | 0.15 | 19 | 0.09 | 0.11 | 14 |
| 3 | 0.08 | 0.09 | 14 | 0.07 | 0.13 | 12 |
| 4 | 0.06 | 0.10 | 20 | 0.04 | 0.05 | 10 |
| 5 | – | 0.15 | 11 | | | |
| 6 | 0.08 | 0.10 | 12 | | | |
| 7 | 0.14 | 0.24 | 11 | | | |
| 8 | – | 0.16 | 17 | – | 0.12 | 14 |
| 9 | – | 0.16 | 16 | | | |
| 10 | 0.15 | 0.19 | 17 | 0.10 | 0.12 | 13 |
| 11 | 0.16 | 0.17 | 17 | 0.08 | 0.11 | 12 |
| 12 | – | 0.13 | 19 | | | |
| 13 | – | 0.18 | 17 | | | |
| 14 | – | 0.22 | 19 | | | |
| 15 | 0.08 | 0.09 | 17 | | | |
| All | 0.11 | 0.14 | 238 | 0.08 | 0.11 | 75 |

* If part of journey outside London (North Circular Rd)

Road, West End Lane, Abbey Road, Grove End Road and Lisson Grove (see Figure 1). These drivers either tended to use all of this route, or to leave the A41 (Finchley Road) somewhere north of Swiss Cottage, to join it. After joining this route, drivers did not normally return to the A41, probably because a difficult right turn onto it would be required. Most drivers either used the A41 for most of their journeys, or diverted off it to the east. Some habitually made the diversion to the east, while others only did so when perceiving heavy traffic ahead on the main route. In almost all cases of diversion to the east, drivers rejoined the A41 at or before (north of) the Swiss Cottage Gyratory, then followed a common course on the main A41 via Finchley Road, Wellington Road and Park Road. Drivers diverting to the east of the A41 tended themselves to stick to their own favourite back street routes, sometimes with minor variations. Figure 3 shows more completely the road network between Fortune Green Road and Swiss Cottage.

To compare between routes, journeys were divided into those by drivers who habitually used the A41, and those by drivers who habitually diverted to the minor roads to the east. Nine drivers were included in this analysis, the remainder either used routes to the west (few) or varied their choice of route, or gave insufficient details of their point of departure from the A41 into the back streets. The variability for the habitual A41 users was based on their travel time from Fortune Green Road to the Swiss Cottage Gyratory exit. For the back street users, variability was based on the time at which they turned off the A41 (at a variety of points south of Fortune Green Road) to the time at which they rejoined it (usually at Swiss Cottage).

The variability of each of these two groups was compared. The results are shown in Table 2. In the summer there were too few panellists to make the comparison. Two facts emerge from Table 2. The first is that average coefficient of variation for both groups is very nearly the same. The second is that, while all users of the main route experienced almost the same amount of variation, the variation of travel times of those using the back streets differed greatly, with two drivers experiencing very little variation and two drivers experiencing very great variation. The causes of varying travel time on the back streets tended to be very specific, such as the daily variations in the difficulty of rejoining the main route or the blocking of narrow back streets by parked vehicles - particularly dustcarts.

Values of variability shown in Table 2 are greater than in Table 1 as the data refer to journeys along only part (one of the most congested parts) of the A41 in inner London.

For individual route sections in the spring and summer it was found that there was a significant positive relationship (at the 5 per cent level) between mean and standard deviation, but that a linear relationship fitted the data just as well as an exponential relationship, whether the exponent was 0.3, 0.5 or 0.7. The linear and all the exponential forms gave an $R^2$ value of between 0.55 and 0.58 for the spring and 0.30 to 0.35 in the summer. As Herman and Lam (1974) had suggested a power relationship would be most appropriate to the centre of a city, the analysis was repeated only for route sections within the North Circular Road. This result is shown in Figure 3, for both seasons. Once again the square root and linear relationships proved equally suited to the data, but the $R^2$ value was increased to 0.69 for both relationships in the spring, with 0.40 (linear) and 0.43 (square root) in the summer.

The relationship between standard deviation and mean was next tested for whole journeys, and finally for that part of the journey within inner London, from the North Circular (or from the origin, if within the North Circular) to the destination. In the spring, for complete journeys, both linear and square root functions gave $R^2$ values of about 0.35 and for the parts within inner London the linear relationship gave an $R^2$ value of 0.62 with the square root function giving a slightly higher $R^2$ of 0.66. In the summer there were only six observations, but for parts within London $R^2$ (linear and square root) was 0.66. For whole routes no significant relationship was found.

This analysis, for both sections and routes, gave the important conclusion that generally a significant relationship exists between the mean and standard deviation of travel time; with standard deviation increasing with increasing mean travel time. It also showed that the relationship is stronger within inner London. When variability was measured by coefficient of variation, it did not increase with increasing mean travel time, however.

### 3.6 Day to day variability

Figure 5 shows the daily changes in the means and standard deviations of travel time for complete journeys throughout the spring (a) and summer (b) surveys. The travel times were converted to 'standardised travel time variates' (see section 3.3 above) to allow the different routes of panellists to be combined. After standardising, the journey time data were combined for all panellists travelling on a given day, and the mean and standard deviation for each day calculated. The mean value indicates days which were generally faster (lower mean) or slower for all panellists. The standard deviation indicates, for each day, whether the standardised travel times between panellists were generally similar (lower standard deviation) or different, indicating the variation between panellists on a given day.

In Figure 5 all journeys in which diversions occurred for non-traffic purposes were excluded. The information shown for the summer survey must be regarded with extreme caution and used only as a guide as there were only six panellists and on many days at least one of these (the person diverting to pick up a passenger)

$$t_i / \bar{t}$$

where: $t_i$ = individual journey time

$\bar{t}$ = mean journey time for a particular panel member

A value of less than one indicates a shorter than average journey and more than one longer than average. Cumulative frequencies of this value were produced for all panellists combined, for the spring and summer surveys separately. The resulting safety margins are shown in Table 3(a) and (b). The general safety margins from the present study are less than has been previously suggested particularly in the summer, as would be expected given that variability in the present study has also been shown to be less. Smeed (1968) suggested the need for a 33 per cent margin above the average for 95 per cent punctual arrival, at an average speed of 20 mph, and more at lower speeds. Thomson (1968) used London data to calculate that a margin of 20 per cent above the mean would have meant lateness on 15 per cent of occasions in 1960 and 17.5 per cent in 1966. The results from the present study indicate that in spring a 20 per cent margin would mean lateness only just over 7 per cent of the time, and in the summer the same margin would mean punctuality on more than 99 per cent of occasions.

Once again, the reason may be that the present study includes journeys beginning far outside central London, so the procedure was repeated for journeys or parts of journeys wholly within the North Circular Road (inner London). The results are shown in Table 4. It is clear that though safety margins within the North Circular are greater than for complete journeys, they are certainly less than in other studies referred to, with a 20 per cent allowance giving 90 and 98 per cent punctuality in spring and summer respectively.

Comparing spring and summer, it is noticeable in Tables 3 and 4 that the summer safety margins needed are much smaller and the difference between spring and summer margins is greatest for complete journeys.

Estimates of safety margins are only relevant to the extent that commuters need to arrive punctually. Of the 15 panellists, only 4 (27 per cent) stated that they had fixed start times; six (40 per cent) had a fixed starting time but were permitted some flexibility about it, while the remaining five (33 per cent) worked formal flexitime. Of those who repeated the survey in the summer, 3 had fixed starting times, two had some flexibility and one worked flexible time. It was also noticeable from the panellists' comments and arrival times that several habitually chose to arrive at their desk considerably earlier than the 'normal' starting time of the office.

In the wider context, of the 130 respondents to the original postcard survey 22 per cent had fixed starting times which had 'to be adhered to'; 45 per cent had a fixed starting time with 'some flexibility allowed', and 34 per cent worked flexitime. The spring panellists reflected the wider survey quite closely in this respect. Given the amount of variability shown in the present survey, and the large majority of car commuters who enjoyed at least some flexibility, it is likely that safety margins are rarely allowed for, and that when they are, the margin is likely to be less than might have been expected. In this respect, it is noteworthy that in the spring and summer surveys combined the panellists in total reported being late on about 14 per cent of occasions and almost all of these were 'slightly' rather than 'very' or 'seriously' late. None of the summer panellists ever reported being late. On those occasions when lateness was reported in the spring, 75 per cent resulted in 'no consequences' indicating that significant lateness occurred on only about 3 per cent of all journeys. On one third of the journeys when 'lateness with consequences' was reported, the tardy commuters had to 'work faster'; on the other two thirds of occasions longer hours had to be worked. Bearing in mind that lateness can result from factors other than variability (car problems, domestic crises, malfunctioning alarm clocks), the consequences of variability appear minor, at least for this sample of commuters.

### 3.8 Predictability of journey times

Related to the question of safety margins is the degree to which car commuters can predict their arrival time within given limits. Panel members were asked to predict their expected arrival time at their destination car park each day, just before starting their journey to work. Table 5 shows a summary of the panellists' predictive errors. It is to be expected that predictability is inversely related to day-to-day variability experienced on a complete route. Figure 6 shows the relationship between the mean absolute error of individual panellists in predicting their arrival time, and the standard deviation of their journey time. Figure 7 shows the relationship between mean absolute error and mean journey time.

In Figures 6 and 7 the summer observations, because small in number are added to those of the spring. One panellist, number 10, has not been included in Figure 6 or Figure 7 for the summer. Of his 14 predictions, 8 were greater than 10 minutes in error with a maximum of 18.5 minutes. In all 14 cases he arrived earlier than predicted. Despite having slightly 'improved' his record of prediction since the spring survey, there was a sense of his not taking this part too seriously and the effect of his observations in such a small sample were severe. He is included in the spring, as he was not then the worst predictor of arrival time, and in the larger sample the effects were not critical.

In Figure 6, the expected relationship is clearly apparent, with a unit increase in standard deviation approximately corresponding to slightly less than a unit increase in mean error. Figure 7 shows mean error related to mean journey time. Again a clear general relationship is apparent though less strong than for standard deviation. A 10 minute increase in mean journey time roughly corresponded to just over one minute increase in mean error.

The cluster of six points together below the best fit line in Figure 7 is of interest: the numbers against the points identify individual panellists. Panellist 15 did not take part in the summer survey, and though panellist 11 was good at prediction in the summer, she was no more than average in the spring. Panellist 3 was successful in prediction in both spring and summer: he had a fixed starting time at work and habitually used the A41 arterial route with no diversions from it. Panellist 4 had a longer average journey in the summer, due to diverting on many days to pick up a passenger (the time waiting for the passenger was recorded by this panellist and subtracted from each day's journey time), but was the most accurate in prediction in both spring and summer, in terms of both mean and maximum error. In both seasons he also experienced least variability. His mean and maximum errors were less in summer than in spring, when his variability was also less. However, panellist 4 was a back street specialist, using usually a total of 15 separate streets to the east of Finchley Road between Heath Drive and Swiss Cottage, with variations according to traffic conditions in these streets. The part of his journey from the North Circular to Heath Drive also included a series of minor roads. This suggests that he at least was able to reduce his variability and increase his predictive accuracy, by an appropriate choice of minor roads. Others who used back streets were often less successful (see Section 3.4 above). One of his typical routes is shown in Figure 3, though he made variations about this in response to back street traffic conditions.

In the summer, accuracy of prediction by the five repeating panellists generally improved, with smaller mean absolute errors and small maxima. This is a result of them experiencing less variability in travel time in the summer but, in repeating the survey, the summer panellists may also have become generally more accomplished in the business of journey time prediction.

Table 5 shows the panellists' ability to predict journey times in more detail, giving the maximum and minimum absolute error for each panellist, in addition to the mean error. This table shows that all panellists but one in the spring were able to predict their journey times to within 10 minutes on average and six managed to predict to within an average of 5 minutes. However the maximum errors shown in the table indicate that sometimes panellists were very inaccurate in their arrival time estimates. For all but one panel member the maximum value was over 10 minutes and for three it was over 20 minutes. The two panellists with the greatest maximum errors in spring were those with the longest journeys and the greatest variability.

Figure 8(a) shows the accuracy of prediction of journey times by all panellists throughout the spring survey and Figure 8(b) for the summer (excluding panellist number 10). The vertical axis shows the mean absolute error in minutes for all panellists travelling on a particular day. The figure shows that certain

v) There was a clear positive relationship between journey time standard deviation and mean journey time which was approximated equally well by a linear or square-root function, both for complete journeys and for journeys (and part-journeys) in inner London. For inner London, the linear relationship was $Y = 0.38 + 0.2X$ ($R^2 = 0.62$) for spring and $Y = 0.41 + 0.14X$ ($R^2 = 0.66$) for summer (Y is the standard deviation and X is the mean, both in minutes). The standard deviation for a given mean was less in summer than spring.

vi) Journey times were generally shorter in summer, during school holidays in spring, and close to public holidays. Rain and traffic-generating events in the study corridor caused journey times to be longer.

vii) The sizes of safety margins required to ensure given percentages of punctual arrivals were smaller than those found in previous studies, particularly in the summer.

viii) Journey time predictability was generally inversely related to journey time standard deviation and, to a lesser extent, mean journey time. Almost all panellists were able to predict their arrival times to within 10 minutes on average.

ix) The predictive ability of panellists did not improve with practice through the spring survey. Mean and maximum predictive errors were less in the summer, either as a result of easier traffic conditions or of longer practice in prediction, or both.

x) Only about a quarter of the panellists (and of the postcard respondents) were expected to begin work at a fixed time. Most of the remainder either had flexibility about a nominal starting time or worked flexitime.

xi) Perceived lateness was reported on only 14 per cent of journeys, and on almost all of these occasions the panellists described themselves as being only 'slightly late' in relation to the day's work tasks. In only about 3 per cent of total journeys did lateness occur which was sufficient to have consequences.

xii) The survey method used in the research was successful and the resulting data were of generally high quality.

Several key points emerge from the work, some of which lead to suggestions for further research. The first is that the variability found in this work is less than that found in previous studies. This may be because of differing methodologies, or because the corridor studied is less variable than those in other studies. Alternatively, it may be because route diversion in response to perceived traffic conditions was included in this study and that knowledgeable regular commuters were thus able to avoid otherwise longer journey times. That journey times were found to be approximately normally distributed (rather than positively skewed) may tend to support this latter explanation.

on this issue, variability is only a valid concept to the extent to which car travellers are familiar with the conditions on the route used. At one extreme is the car driver who uses the same route ever day: at the other is the car driver who drives to a destination in an area with which he is completely unfamiliar. In the latter case, although a loss may occur due to early or late arrival at an appointment, it is not attributable to variability, but to the wider issue of unpredictability, in this case due to lack of prior knowledge. Between these two extremes lie a large proportion of car journeys, indicating the difficulty of analysing and predicting the full extent and effects of variability of journey time. The introduction of driver information systems can be expected to reduce unpredictability in general, and therefore time loss and frustration. The unimportance of punctuality revealed by this study suggests that attention should be given also to the frustration resulting from unexpected delays, as one component of car journey quality.

Another outcome of this work, and of potential importance for policy, is the effect on travel times of the use of back street routes. Though based on limited data and on only part of the A41 corridor, the results show that users of back streets were generally able to reduce their mean journey times without, as a group, increasing their variability. However, while variability on the main route was similar between users, variability experienced by individual users of back streets was very different. Although some chose back street routes which reduced their mean but increased their variability, others were successful in choosing routes which reduced both mean and variability to levels well below those on the main route. An investigation of the scale of back street use, and an evaluation of it in terms of the apparent economic benefits to back street users and to main route traffic, against the environmental effects caused, might be a useful input to area traffic management policy development.

The summary and conclusions lead to the following recommendations for further investigation.

i) The effects on travel time and its variability of diversion in response to perceived traffic conditions could be more fully investigated. A variation of survey method would need to be considered, to include more timing points to enable comparisons to be made between alternative back street routes and between back street and main roads.

ii) The study of diversion could be extended to investigate the scale of back street use, either regular or in response to traffic conditions, with the objective of comparing the probable benefits to longer-distance drivers with the effects on local access and the environment.

iii) The question of perception of lateness, and particularly earliness, could be explored in more detail with a view to gaining a more complete assessment of their consequences. This would be likely to need investigation also of commuters' evening journey from work.

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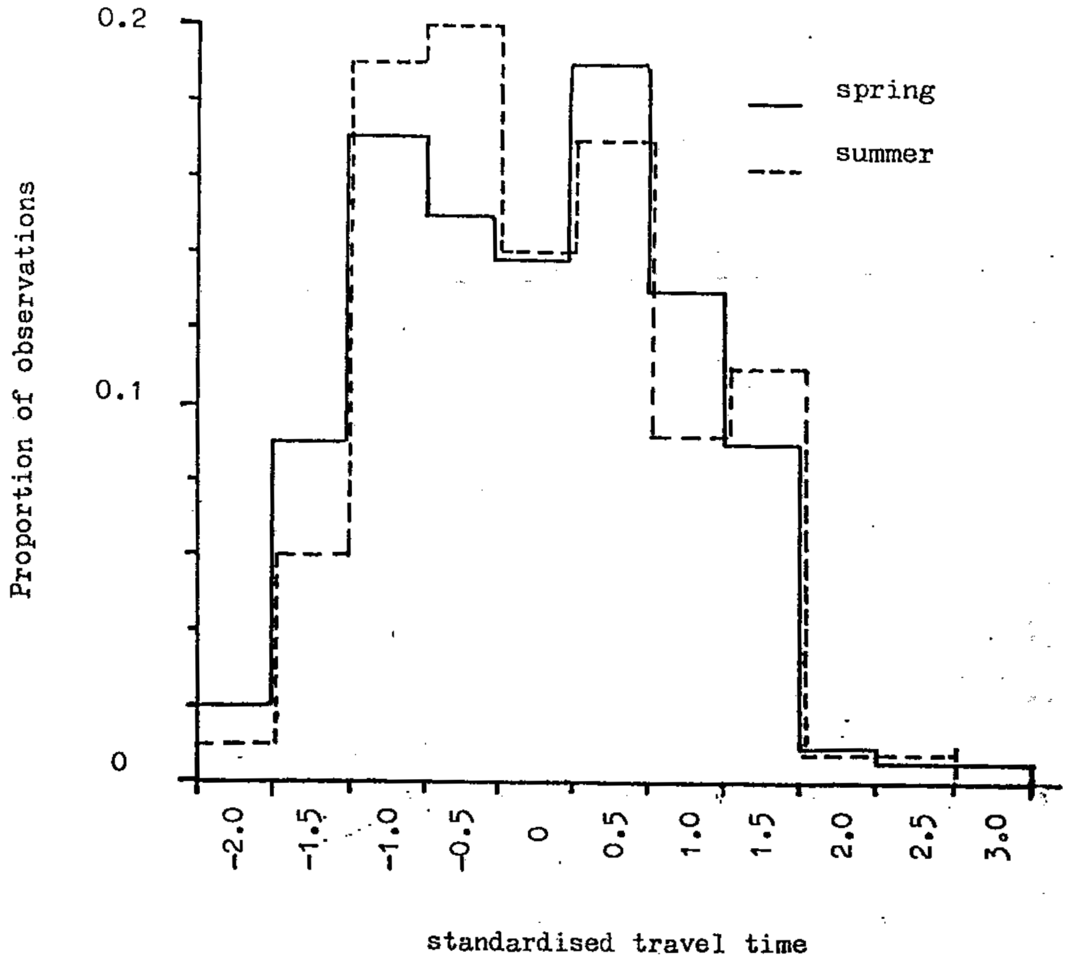
Figure 2: Journey time distributions




**Note:** standardised travel time is defined as:

$$X_i = \frac{(t_i - \bar{t})}{s}$$

where: $X_i$ is the standardised travel time for journey i

$t_i$ is the travel time for journey i

$\bar{t}$ is the mean travel time for all journeys by that person

s is the standard deviation of all journeys by that person

Figure 4: Mean and standard deviation of journey time
(links in inner London)

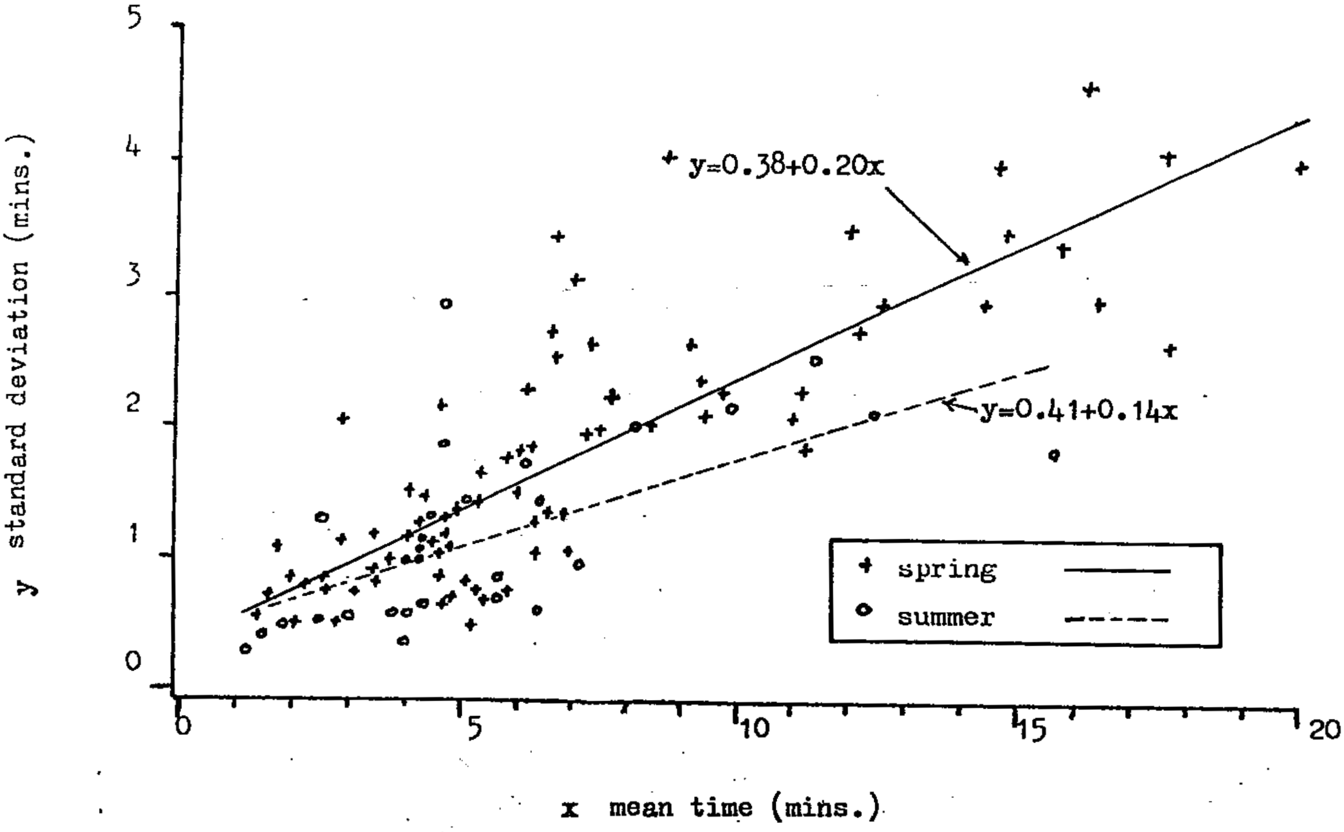


**Figure 5(b):** Daily variation in mean and standard deviation of standardised travel time (summer)

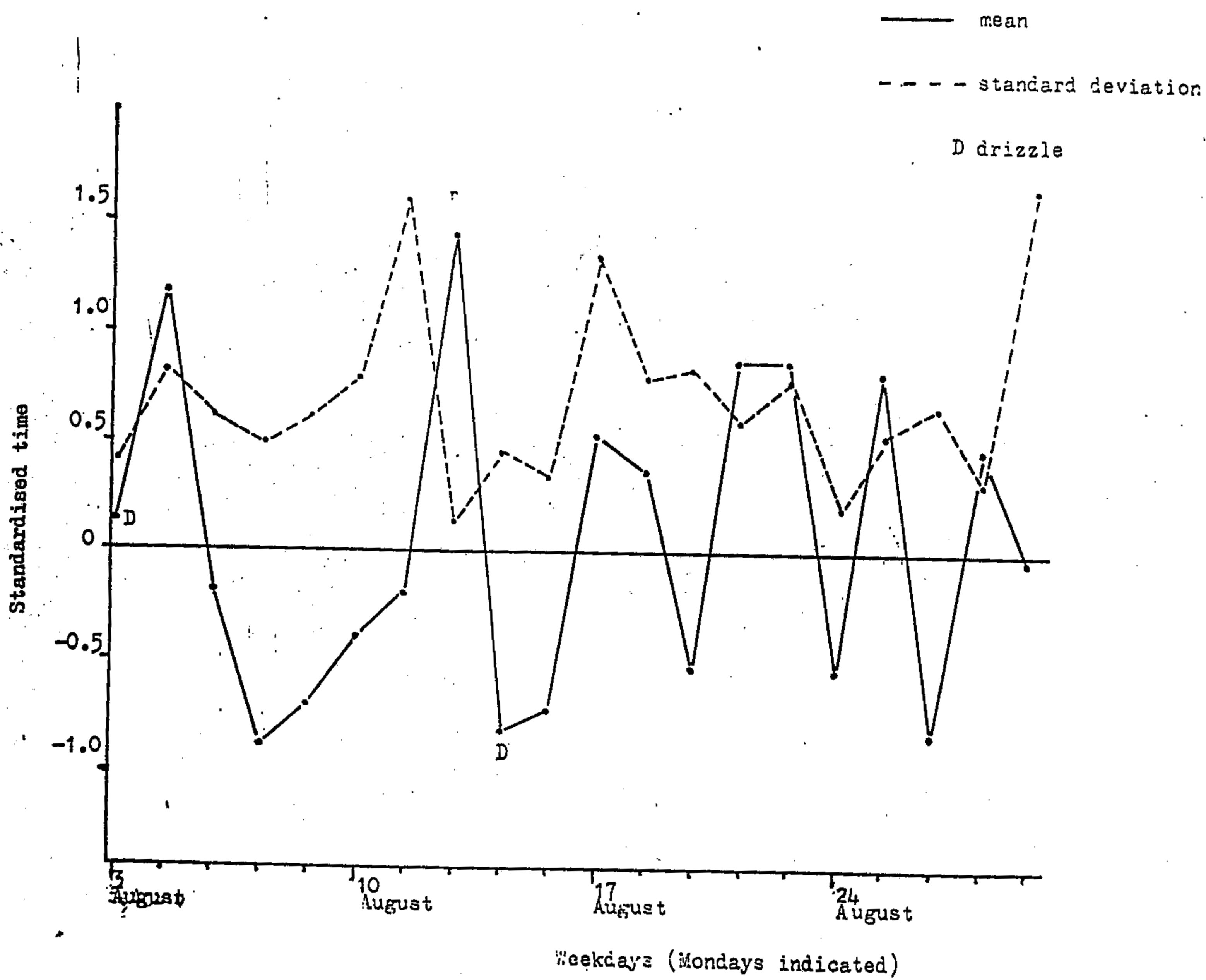


Figure 7: Predictive error and mean journey duration

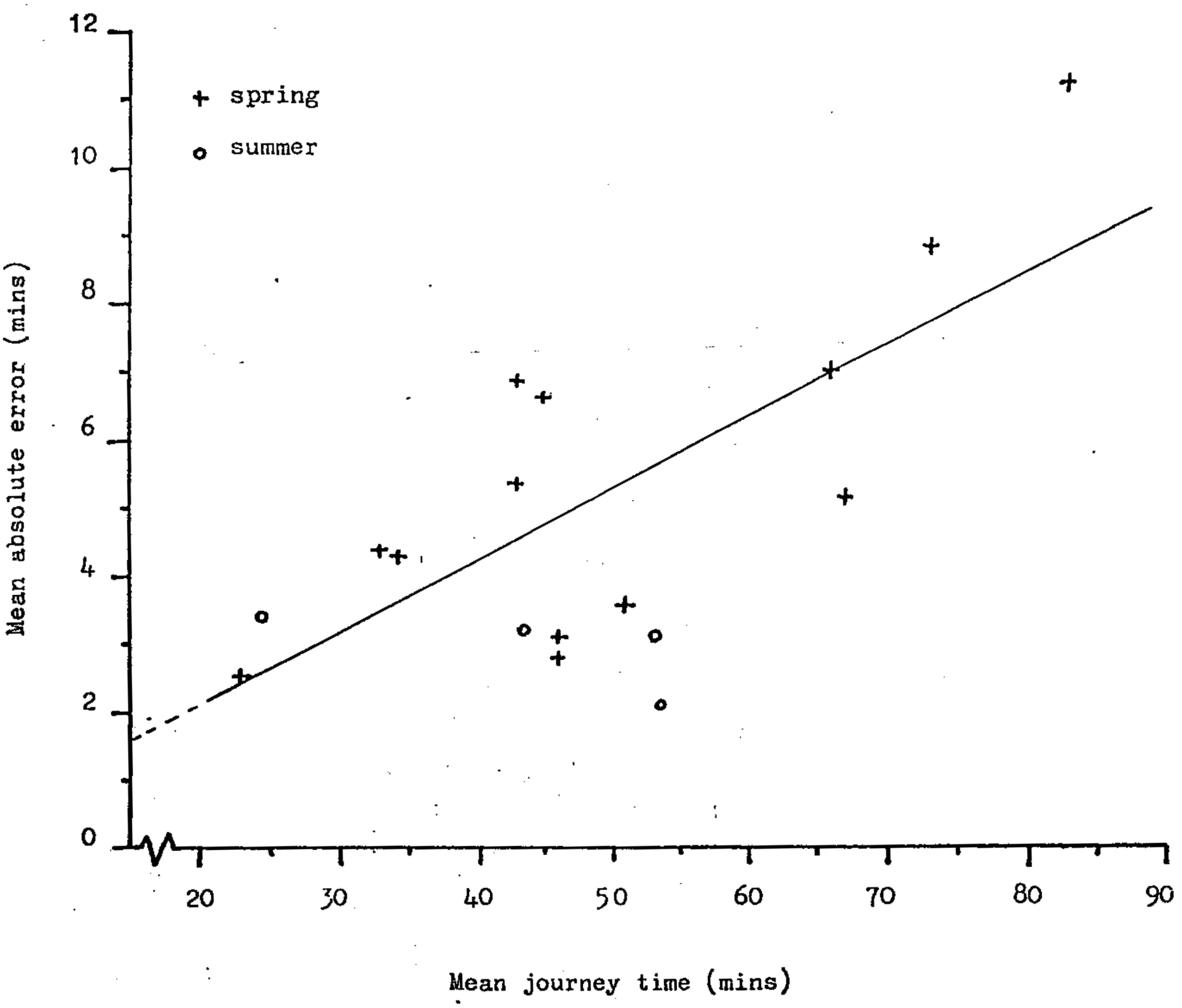


Figure 8(b): Daily mean journey time predictability (summer)