INVESTIGATING HOUSEHOLD ACTIVITY-TRAVEL PATTERNS IN ADELAIDE

P. M. JONES,
Oxford University Transport Studies Unit

M. I. CLARKE,
Oxford University Transport Studies Unit

L. M. OXLAD,
South Australia Department of Transport

ABSTRACT: The objective of the study is to provide the South Australia Department of Transport with a set of practical activity-based planning techniques that can be used to address certain policy issues (particularly those affecting the timing of travel and activities, or where complex adaptations and non-travel impacts are anticipated).

This paper summarises findings from the first stage of the study, comprising exploratory in-depth interviews in Adelaide and various analyses of an activity data set. Examples are given of work on day-to-day variability in behaviour, and household responses to peak-spreading policies involving changes in school hours. Policy implications are discussed and the programme of work for the remainder of the study is outlined.

1. BACKGROUND TO THE STUDY

In order to fully assess urban transport problems, devise policies, evaluate options, and monitor impacts,governments require adequate data bases and a sound technical basis for planning. The first comprehensive attempt to develop an integrated data base and a package of transport planning techniques for Adelaide was in the mid-sixties in the Metropolitan Adelaide Transportation Study (MATS); this incorporated aggregate state-of-the-art models for forecasting trip generation (regression analysis), trip distribution (gravity model), mode choice (diversion curves) and route assignment (minimum path with rudimentary capacity restraint).

By the mid-seventies the MATS data base needed updating and the models were proving unsuitable for current planning needs, both because of known theoretical deficiences in the methods and because of the changing policy emphasis. The MATS models were designed to address strategic, long-term issues and implicity assumed a continuation of the growth patterns of the sixties. Following the oil crisis, cut backs in investment and growing public awareness of transport issues, the policy emphasis switched more to shorter-term, local concerns, in which it became necessary to understand how the population adapted to changing conditions, rather than assume a continuation of past trends.

In 1976 the S.A. Department of Transport and the Highways Department jointly funded the Metropolitan Adelaide Data Base Study (MADBS), to meet these new demands. Specifically, to provide a more comprehensive and current database of household, person and travel information for metropolitan Adelaide for use in transport planning and policy analysis; and, to develop a suite of aggregate and disaggregate transport models based on recent theory of travel behaviour and operating within the UTPS software package. The transport planning techniques now used in Adelaide are enhancements and further developments of the MADBS models.

Recently, however, attempts have been made to broaden the range of urban transportation planning techniques available to the Department. At one extreme, through the development of sketch planning tools, limited to census data, and at the other by developing a more micro capability to explore household travel behaviour and activity patterns in depth. It is with this latter area of work that this paper is concerned.

The Department have appointed the Oxford University Transport Studies Unit (TSU) to develop and apply activity-based techniques to investigate household activity-travel patterns in Adelaide, drawing on research into travel behaviour which has been carried out at ISU over the past ten years. From an activity perspective, travel patterns are seen as an outcome of wider decisions about daily patterns of living, which are affected by roles, personal preferences and a variety of temporal, spatial and economic constraints. A number of these factors come together in the family life cycle variable, where changing roles and household composition

hence an important impact on what needs to be done, when and where, and hence on daily and weekly patterns of travel.

In this approach travel is treated explicitly as a derived demand, and it is possible to identify the impacts on travel patterns both of transport policies (e.g. road pricing) and non-transport policies (e.g. changes in shop opening hours). The approach is especially well suited to examining issues which affect the timing of travel or other activities, or which may involve complex interactions among household members, or have important social consequences. For example, policies affecting institutional opening hours (e.g. schools, hospitals), the provision of public transport services, or broader changes arising from energy shortages or changes in social patterns of work or leisure.

This work is seen as complementary to, rather than a substitute for, the disaggregate models derived from MADBS, as it offers a means of examining the social aspects and non-transport impacts of policies in ways that cannot be achieved using disaggregate trip-based models. It also provides local insights which could then be examined in a more general way at a metropolitan-wide scale using existing aggregate models.

In this paper we give a brief overview of work completed to date (section 2) and then describe selected aspects of the work in more detail (sections 3 and 4); some policy implications of the work so far are discussed in section 5. The programme of work for the remainder of the study is outlined in section 6, and we conclude with an assessment of what has been achieved to date, and proposals for further research. Full details of the work completed to date are provided in Clarke, et al (1986) and Jones, et al (1986).

2. OUTLINE OF THE STUDY

Objectives and Structure

The objectives of this two-year study are to demonstrate the relevance of an activity-oriented perspective on transport planning in Adelaide, and to develop a set of activity-based survey and analysis procedures that could be used by staff of the South Australia Department of Transport, to help investigate certain types of policy issue.

The work has been planned in two phases. The first (Stage I) is an exploratory/developmental phase, in which existing activity techniques are adapted and applied in Adelaide to show the relevance of the approach to transport planning issues, and some preliminary development work is undertaken to devise new procedures to meet the specific requirements of the Department. The second part of the study (comprising Stages II and III) focusses on the development of two new planning tools: an interactive analysis package that can be used to provide information about aspects of household activity-travel patterns, using either activity or trip data; and a survey technique that can identify household responses, preferences and priorities among policy options.

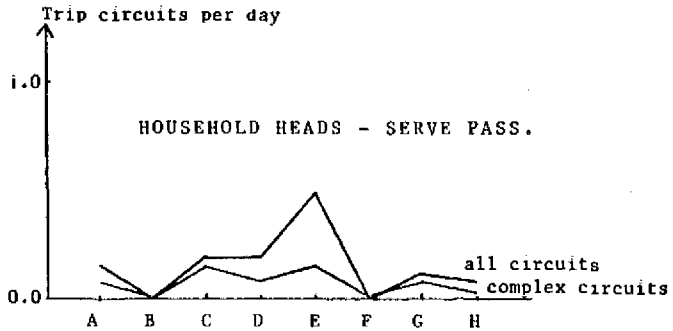
Stage I is now complete and the second phase of the study is underway. The work began in Oxford with a review of previous studies and the analaysis of an Adelaide activity data set using existing programs; and then moved to Adelaide, where a small exploratory survey and further analysis of the activity data were undertaken. This paper presents some results from the work completed to date, and in section 6 we briefly outline the specification for the analysis and survey techniques now in the process of development.

Overview of the Study

The empirical work began with a repetition of analyses previously carried out on a U.K. activity diary data set using the seven-day data from the Adelaide Travel Demand and Time Allocation Study (Barnard, 1984) completed in 1981. This analysis covered both measures of travel behaviour (trip rates, trip circuits, time of day profiles) and less conventional measures of activity behaviour, using plots of activity schedules (i.e. allocation of time to activity, by time of day) and a more formal analysis of time allocation using discriminant and cluster analysis on the time budgets of adults in different life cycle groups. Methods used were similar to those reported in Jones et al (1983).

Figure 1 illustrates one aspect of the analysis of trip circuits by eight lifecycle groups, namely the incidence of tours involving serve passenger trips. Note that there is a sharp peak in simple circuits (i.e. home-serve passenger-home) for spouses in lifecycle group C, associated with chauffeuring young children to/from school (while accompanied by pre-school children); complex circuits, where other non-home activities are carried out on the same tour away from home, are more common in group D, probably because by this stage all children are at school and mothers have less need to be home-based during the daytime period. For household heads, simple and complex circuits peak in group E, which reflects their role as evening chauffeurs taking older children to/from activities in the late afternoon or evening (once they are home from work).

In general, these analyses found more similarities than differences between the U.K. and Adelaide data sets. The striking impression gained was one of similarity in the general structure of the results, with detailed variations caused by differences in life-styles between a small English town (c. 30,000) and an Australian city. Car use was much higher in the latter, as was the extent to which adults accompanied children on various activities; better weather conditions also encouraged more outdoor activity - but, in general, the requirements and constraints associated with different life cycle stages produced a marked uniformity. This was confirmed in subsequent qualitative work in Adelaide (reported below), where the concerns and interests relating to travel and everyday living expressed by residents were virtually indistinguishable from the comments made by English families in the same groups.



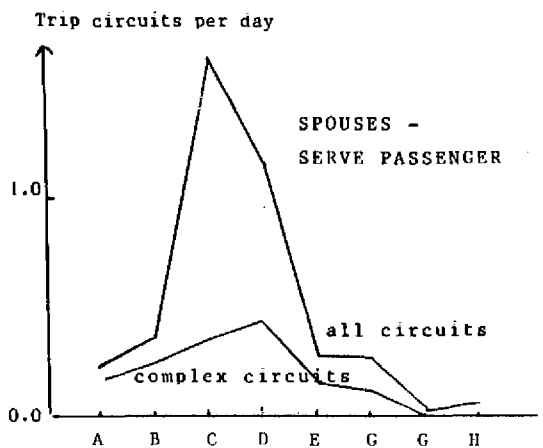


Figure 1: Differences in Serve Passenger Trip Circuits, by Life Cycle Group

Descriptions and Definitions of Lifecycle Groups

	Description of Group	Definitive Feature(s)
A	Younger (married) adults without children	Youngest person under 35 and no children
B	Families with pre-school children	All children under 5
C	Families with pre-school children *and* young school children	Youngest child under 5 and another child 5 or over
D	Families with young school children	Youngest child 5 or over but under 12
E	Families with older school children	Youngest child 12 or over but under 16
F	Families of adults, all of working age	Youngest 'child' 16 or over
G	Older adults, no children in household	Youngest person 35 or over *unless* in Group H
H	Retired persons	All persons 65 or over, or at least one 65 or over and none with full time job

HOUSEHOLD ACTIVITY-TRAVEL PATTERNS IN ADELAIDE

Twenty households were interviewed in-depth in March 1985, using the Household Activity-Travel Simulator (HATS): an activity-based, interactive survey technique which uses visual display equipment to explore household activity patterns and help simulate response to change. An example of a completed board is shown in Figure 2, which demonstrates some of the basic concepts of the activity approach; note the way in which travel is seen as part of a complete daily pattern of behaviour, in which interactions with other activities can be examined explicitly in a time-space context.

Interviews lasted from 1½-2 hours, within a loosely structured format. Households were drawn from the eastern suburbs of Adelaide (in the area covered by the AIDAIAS survey) and comprised couples with one or more children of school age or below (i.e. lifecycle groups B-E), where at least one parent worked full time. Respondents kept a one-day diary of their activities prior to the interview, and first discussed in depth the reasons for, and problems associated with, their existing patterns of behaviour. They were then asked to simulate the effects that various peak-spreading policies would have on the daily life of their households. After each policy had been considered, a note was made of the main positive and negative impacts of that proposal on family life, and at the end of the interview respondents were invited to reassess their evaluations and provide a rank ordering of the options, including the 'do-nothing' option. Analyses were based on transcripts from each interview, specific case-study simulations and a re-analysis of the AIDAIAS data, to explore issues raised during the HATS interviews.

The discussion of existing patterns of behaviour by families is a very valuable adjunct to the types of analyses carried out using activity or travel diary data, since it can both help to generate hypothesis for further examination of the data and, more significantly, can add dimensions to the understanding of travel which cannot be gleaned in other ways. People talk, for example, of being 'under pressure' at certain times of day, or of certain activities (e.g. shared evening meal, or tidying up after the children go to school before leaving for work) being very important to them. Working mothers in particular reported being in a great rush and relied heavily on the use of a car to be able to pack everything into the day; if the car became unavailable temporarily, things would be rescheduled, re-allocated or abandoned, rather than attempting to maintain the same activity pattern by bus. As one respondent explained,

> "I wouldn't even consider working if I had to catch public transport."

Clear differences can be identified in household behaviour, priorities and constraints as children grow up and become more independent - giving parents both greater freedom at certain times of day, but with the children also making greater demands on them as chauffeurs, and ultimately competing directly for the use of the household car(s). As institutional

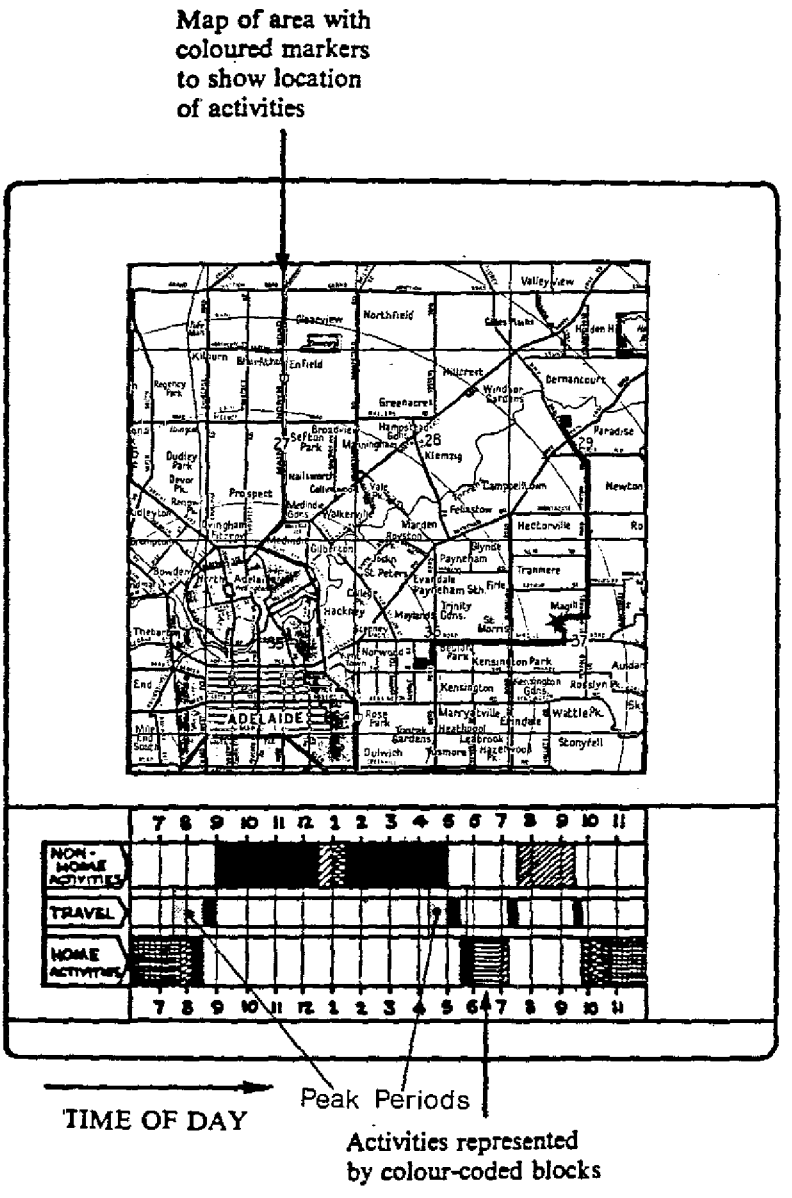


Figure 2: Example of a Completed HAIS Display Board

constraints increase in lifecycle groups C and D (with children at school and both parents often working), families talk of establishing clear 'routines' to cope with the pressures.

In our U.K. studies one worry to emerge again and again has been the reliability of bus services, particularly when mothers have to get from town to meet young children from school. While this is less of a problem in a more car-oriented society, we did find that other aspects of transport provision could cause equal degrees of concern: in particular, the fear of traffic delays or of being stuck in a multi-storey car park and unable to get out.

Although the HAIS boards focus directly on one day's behaviour, the discussion enables consideration of routines at a weekly or monthly, as well as daily, levels. An analysis of the transcripts prompted us to look more closely at weekly patterns of certain activities in the AIDATAS survey. Table 1 shows the distribution of frequency of participation across weekdays for five broad groups of activity. While all adults travelled at least once in the survey week, less than half initiated a serve-passenger trip, though over 85% shopped or took part in some other out-of-home activity at least once. About three-quarters of the sample travelled every weekday, but about 10% did so on only three days or less per week; note the fairly even distribution of participation rates for shopping and other out-of-home activities, and the strong negative skew for work/education and positive skew for serve passenger activities. We also examined the timing aspects of repetitive behaviour over the week, and developed some measures of variability: these are discussed in section 3.

TABLE 1: Distribution of Respondents by Activity Type and Frequency of Participation

ACTIVITY TYPE:	NUMBER OF DAYS PER WEEK (Monday-Friday)						
	0	1	2	3	4	5	% participating at least once per week
	% distribution of participants						
Travel	-	1	2	6	14	77	100%
Work/Education	-	5	5	9	10	71	71%
Shopping	-	22	22	22	21	13	86%
Serve Passenger	-	43	20	10	10	17	43%
Other Out-of-home	-	23	25	23	15	14	87%

Source: AIDATAS Survey

Having identified existing patterns of behaviour, and the constraints, opportunities and preferences which help shape them, it is then possible to go one step further in the HAIS interviews and simulate the responses of household members to various transport-related policies of interest to the decision-maker. These may either

be directly related to transport provision or control (e.g. changes in bus services or parking availability), or indirectly affect travel through changes in institutional constraints. In order to demonstrate the range and complexity of issues that could be examined from an activity perspective, it was decided to focus on the problem of peak period travel and to simulate the effects that various peak-spreading policies would have on the daily life of respondents.

The following policies were considered: earlier and later school hours, revisions to work hours, and peak travel surcharges. The study was able to identify a wide range of impacts, affecting many aspects of family life (both inside and outside the home) as well as the school and work environment, in addition to the expected direct travel consequences. Because of re-arrangements of household responsibilities and re-structuring of routines, however, the interviews also identified important secondary effects which impact on travel behaviour. Some of the findings are presented in section 4.

When carrying out a small, exploratory study of this nature, we are interested in understanding the reasons for observed behaviour, the processes involved in adaptation and the range of responses that a policy is likely to invoke - rather than attempt to forecast specific responses, from such small samples. To meet the latter objective, it would be necessary to follow the exploratory study with a larger more structured survey (for which a suitable methodology will be developed in the second part of this study), or use the findings as an input to a more formal modelling process. Nevertheless, confidence in the study's conclusions can be enhanced by reference to findings from similar work carried out in other countries - especially if we can find evidence of similar processes and preferences (even though specific behaviour may vary).

As part of our study we carried out an international review of responses to school hour changes, work hour revisions and peak travel surcharges, and concluded that the Adelaide findings were consistent with - though not identical to - the results from other countries. Unlike a purely empirical, aggregate analysis, however, where differences may be seen as a cause for concern, when dealing with household behaviour at a detailed level variations in response are often very illuminating and serve to enhance the understanding of the processes at work. Thus, we were able to attribute differences in responses to peak surcharges, for example, to the greater dependence on car travel in Adelaide, the lower levels of congestion, and the relatively dispersed urban structure, compared with areas where such schemes have been introduced successfully.

Because of the free-ranging nature of the HAIS interviews, they often uncover information that is not directly relevant to the issue under consideration, but which nevertheless may be of importance in a wider policy context. In the course of this study, for example, useful information was obtained about attitudes towards urban bus services, the prevelance of company car ownership and use, temporal linkages among industries, and the influence on travel of residential location and other long-term decisions.

An important test of the value of research work carried out for a government organisation must be the policy-relevance of the findings. From an analysis of the ATDATAS survey, the insights from the HATS surveys and a limited re-analysis of the larger MADBS data base, it has been possible to draw a number of conclusions of direct policy relevance, as well as provide information about household travel problems, preferences and responses that can help inform more general debate about transport policy in Adelaide. Some of the policy implications of the first stage of our work are discussed in section 5.

3. INVESTIGATING DAY-TO-DAY VARIATIONS IN BEHAVIOUR

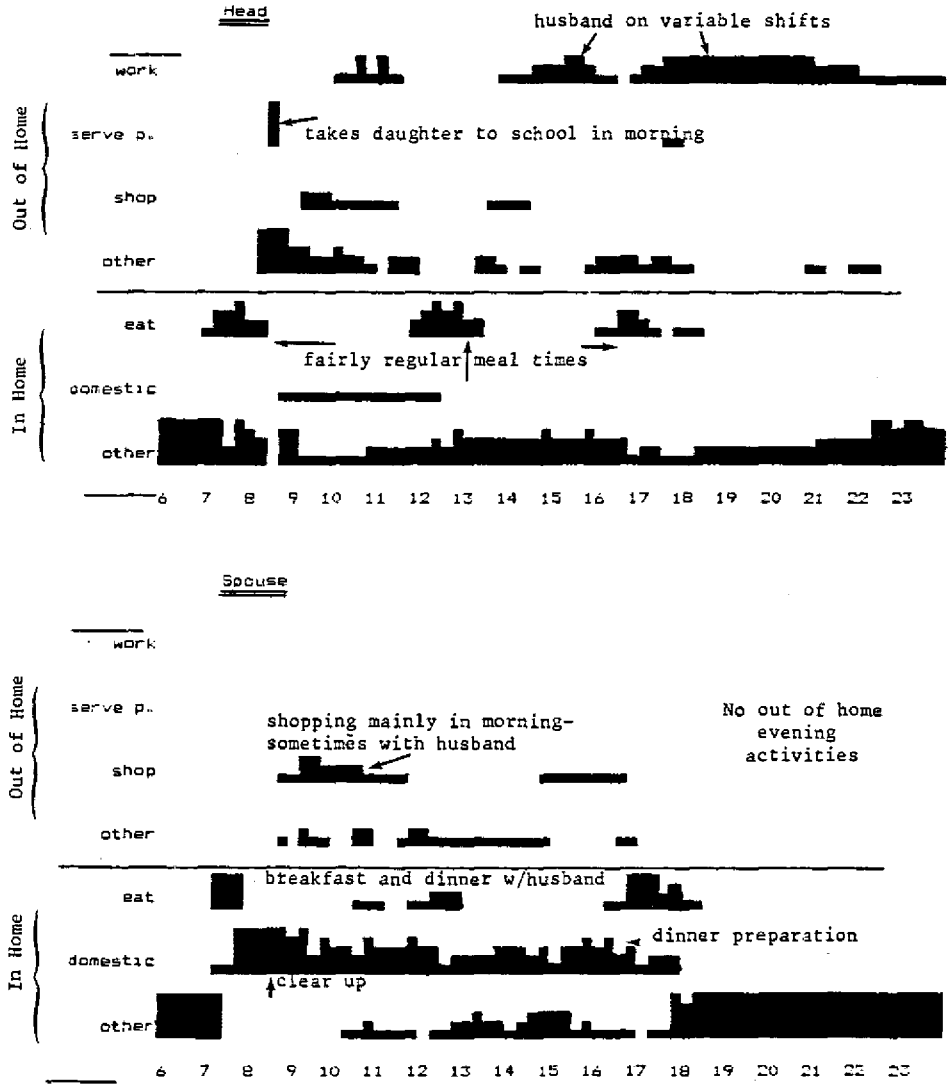
Although most respondents were able to characterise their behaviour in terms of a daily routine, there were clearly important differences in activity patterns from day-to-day, both caused by changes in the timing of a daily activity (e.g. finish work early on Fridays) and the less frequent occurrence of shopping and certain extra-curricula children's activities. With the normal one day travel data sets, such as MADBS, it is not possible to differentiate between inter- and intra-person variability, but the 7-day ATDATAS survey provided an opportunity to examine this issue. Preliminary analyses were carried out by devising three different types of measure, in order to explore the degree of stability and routinisation in household activity patterns across days of the week. All results presented here relate to Monday-Friday behaviour only.

Individual Representation

The simplest way of examining day-to-day variations in activity patterns graphically is to plot the frequency with which an activity is carried out in a given time period, for the five days of the week. This measure is shown for adults in one lifecycle group E household in Figure 3. Time of day is represented along the horizontal axis and the various categories of activity which make up the day are displayed on the vertical one - such that each activity is covered by one of the categories - and grouped into in-home and out-of-home activities. Up to five bars can be shown under each activity group, each representing a day on which the activity is carried out at that time. A histogram of weekday activity participation is constructed for each 15 minute time period, and an activity is registered if it occurs at all in that period; hence there is some overlap in the distributions, since a person may record more than one activity within the same unit of time.

The degree of similarity in day-to-day behaviour is apparent from the type of picture that results: the taller the histogram for each activity, the more often in the week that activity occurs at about that time of day, and the more square the blocks the more precisely the reported start and finish times coincide from day-to-day - exact coincidence,

Figure 3 : Weekday Variation in Behaviour for Parents in a Group E Household



(Husband=54, Wife=48, Daughter=15)

Source: AIDAIAS Survey

however, may say more about the way the diary has been filled in than about actual behaviour! The figure is largely self-explanatory: note, for example, that the daughter gets a lift to school at the same time every day, but makes her own way home.

Aggregate Representation

The type of representation shown in Figure 3 provides a useful picture of variability in one household weekly behaviour, but would quickly became unmanageable if we wanted to look at a fine categorisation of activities or compare or categorise all but a small number of households. We next explore a different approach, which looks at activities individually, but measures the extent of similarity in individual day-to-day behaviour for groups of the population.

Figure 4 illustrates the method applied to travel and work/education activities undertaken by adults. Time of day is on the horizontal axis in 15 minute periods (from 06.30 to 24.00), and the vertical axis shows the total number of occurrences over five days of the activity in each time period (total height of column), identifying what number of those occurrences are repeated at the same time on different numbers of days (e.g. 4 = the activity is carried out by the same individuals at that time on four out of five days of the week). Since the scale measures occurrences over the week, not individuals, an activity occurring at the same time on 'n' days a week will be weighted 'n' times an activity which occurs on only one day at that time.

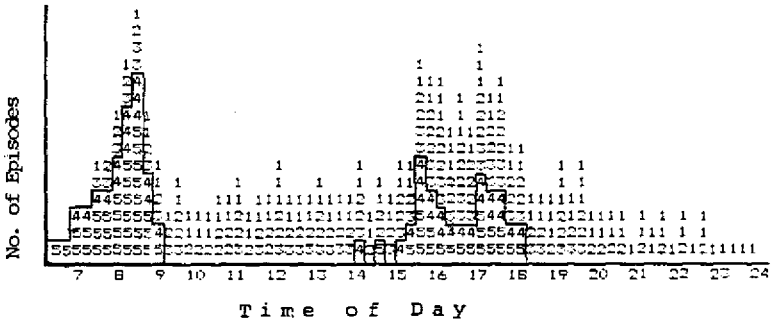
A line has been drawn between the 3 and 4 days/week level, to distinguish roughly between daily/highly routinised and less frequent/more variable behaviour. In the case of travel, we can see a marked stability in peak travel(especially in the morning) and more variability in inter-peak and evening travel; the two afternoon peaks correspond to school and work finish times. Not surprisingly, work/education show very high levels of stability through the day and similarity from day-to-day, especially with regard to morning start times; there is more variability in the evenings - which causes the variability in travel - probably associated with the employment of part-time workers, and the variable finish times of some full-time workers (see below).

The representation used in Figure 4 is very effective at showing the extent of routinisation associated with different activities, and highlights those time periods when the same individuals are carrying out the same activity over the week. However, although it is factually correct, the interpretation of the diagram is ambiguous. A high proportion of 1's and 2's (as found with plots of shopping patterns) could imply one of two things:

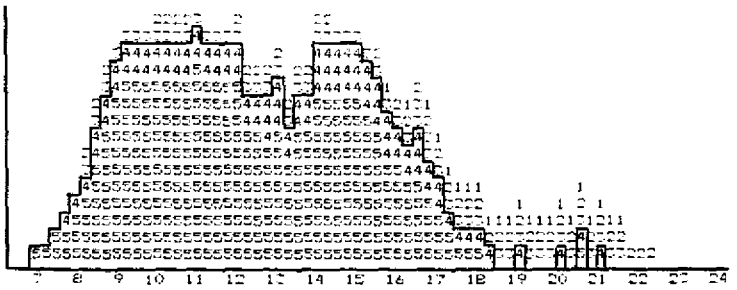
Figure 4: Aggregate Measure of Variability in Behaviour, For Travel and Work/Education

(Number of recorded episodes that take place at the same time over the five day recording period, for individuals sampled)

TRAVEL:



WORK/EDUCAIION:



(i) Most people carry out the activity only on one or two days per week; or

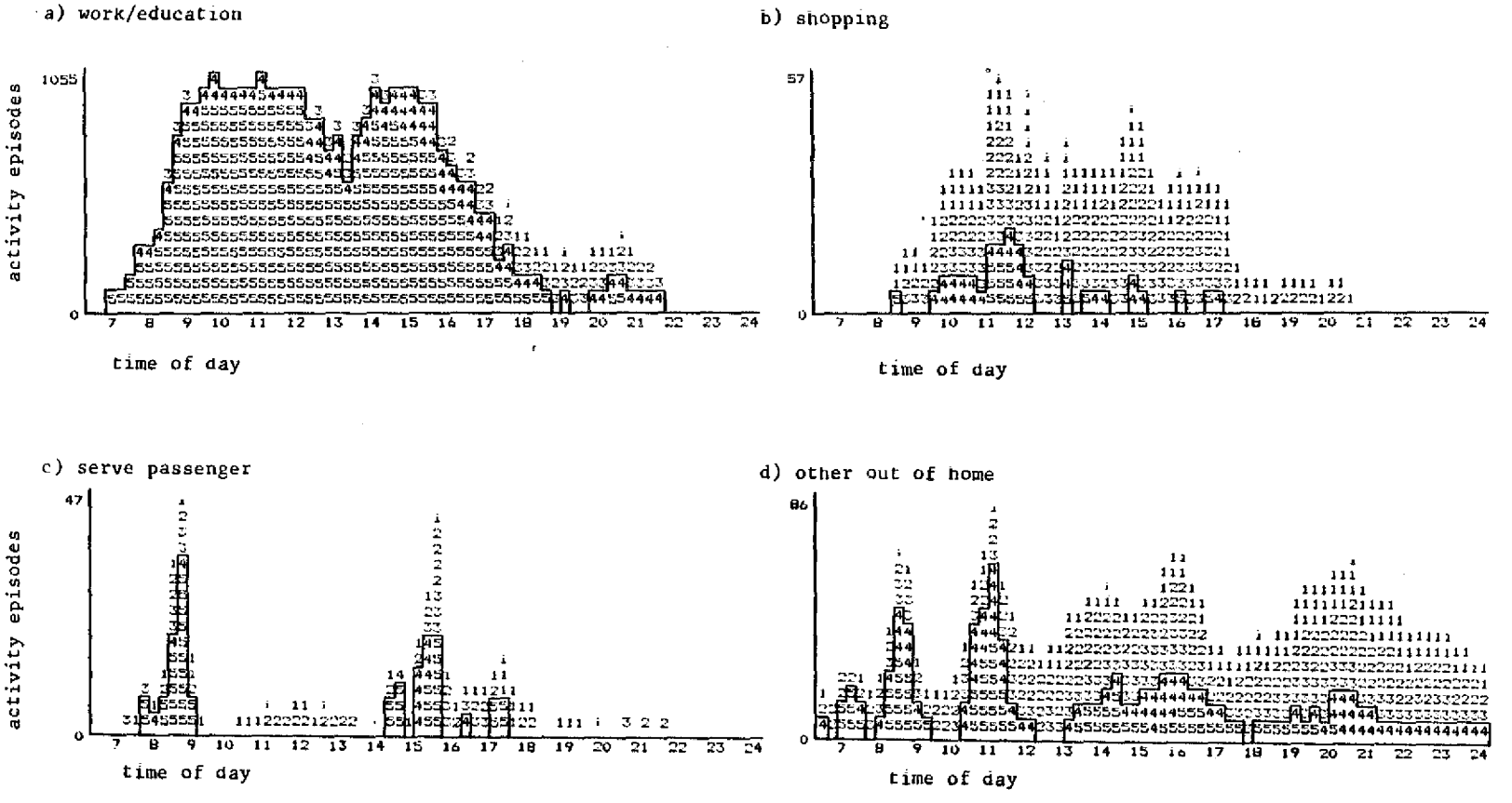
(ii) The activity is carried out more frequently than this, but at varying times from day to day - so that it is the degree of coincidence rather than the level of participation which is low.

This ambiguity can be avoided by filtering respondents according to the number of days per week in which the activity is carried out; Figure 5 shows examples of variability in activity participation only for people who reported carrying out the activity at least once on each of the weekdays. Thus, if everyone took part in the activity at exactly the same time each day, then all entries would be '5'. Compared with the total sample, we find some interesting similarities and differences:

- Work/education becomes even more highly routinised during the day, but there is still quite a considerable variation in the evening, after around 17.00, suggesting that finish times are quite variable for a significant proportion of full-time workers.
- We find a higher proportion of routinised episodes for people who shop five days a week, but there is still a predominance of variable behaviour, especially in the afternoons. Note that the daily shoppers tend to have quite marked peaks in their shopping, in mid-morning and mid-afternoon - possibly linked to the school day?
- Serve passenger shows some increase in routinisation as a result of this filtering, but only around half the episodes in the afternoon are carried out regularly, suggesting that pick-up times are more variable than drop-off times in the morning, or that some respondents collect children less frequently than they take them to school.
- Some of the biggest contrasts are found in the other out-of-home activities, where both the peaks are more intense when only daily participants are included, and the extent of routinisation increases markedly, especially in the morning. There is still a substantial variability in the afternoon and evening periods, however.

The analyses presented above could be extended, to look at differences by household or person type or area, but difficulties arise in making visual comparisons and in assessing which groups are more routinised in their behaviour. One solution to this problem - though at the expense of losing some of the detailed timing information - is to develop an index of similarity between activity patterns.

Figure 5: Variability in Behaviour Among People Who Participate in the Activity on Each Weekday



Source: ATDATAS Survey

Similarity Index

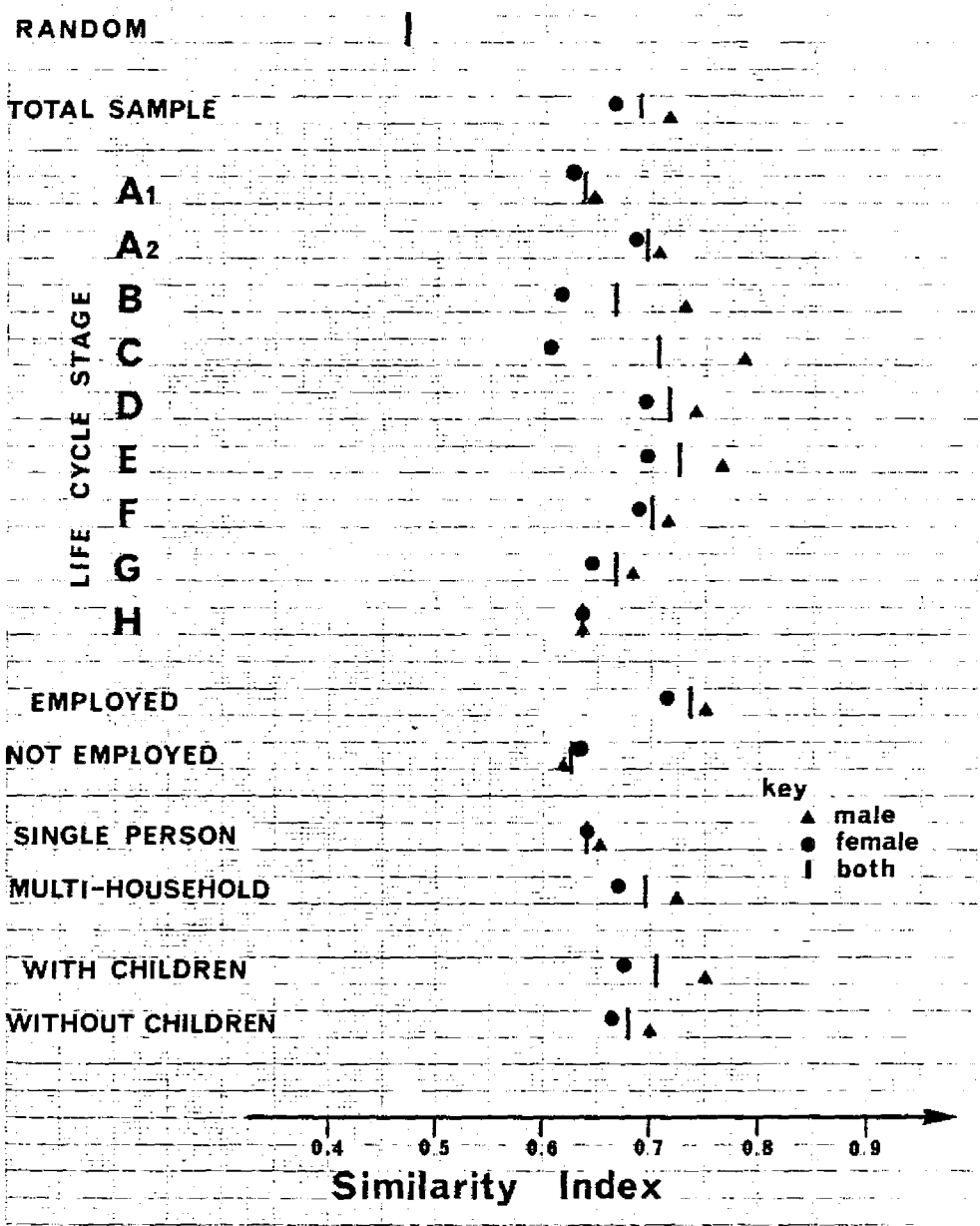
The measurement of activity patterns in terms of indexes is a complex problem which has not yet been fully resolved, but for illustrative purposes we have developed a simple index of the regularity of behaviour over the Monday-Friday period. This is calculated by comparing behaviour on pairs of days; the average weekday value for an individual is taken as the mean of all day-to-day comparisons, and values for various population groups of interest are obtained by averaging the relevant individual values. The basic index is derived by assigning a '1' for each 15 minute period if the same type of activity is taking place in the same 15 minute interval on both days, and '0.5' if they occur within 45 minutes of one another; otherwise an '0' is recorded. The score is then summed over the whole day and normalised (in relation to a measure of complete similarity, i.e. 96 = 1 x 96 time periods), to give a similarity index from 0 to 1.

The results for various population groupings in the ATDAIAS survey are shown in Figure 6. The base point for comparisons is the random value, which shows the level of similarity observed when randomly chosen pairs of diary days are compared. All the population sub-groups score substantially higher on the similarity score than this. Note, in particular that:

- Men generally show less day-to-day variation in their weekday behaviour than women (i.e. men never score less on the index than the comparable female group);
- Differences between men and women are greatest in lifecycle groups B & C, which contain pre-school children and a very small proportion of working wives;
- There are vitually no differences in the degree of variability in weekday behaviour between men and women where their roles or lifestyles are most similar, namely: retired people, single people and people who are not working - although taking both sexes together, these groups score relatively low on the similarity index;
- Overall, working people have the highest mean index and non-working people the lowest, demonstrating the effect of work patterns on the overall structure of weekday behaviour

This confirms that the groups who show most highly constrained activity patterns on one weekday tend to be the people whose behaviour is most routinised and hence similar over the week. Note also, from Figures 4 and 5 that it is the activities associated with peak movements on the transport networks that tend to be most repetitive and habitual; this suggests that the approach adopted in the HATS interviews, of focussing primarily on one day's peak-period travel, gives a good approximation to likely responses over a complete working week.

Figure 6: Similarity Scores for Weekday Behaviour by Population Group



4. IDENTIFYING REACTIONS TO SCHOOL HOUR CHANGES

The HATS interviews were able to probe both the qualitative and likely quantitative responses to various peak-spreading policies. Here we summarise responses to one of the school day options, to give an indication of the types of information that could be obtained from exploratory interviews of this form.

Earlier School Hours

This involved quite a major shift in school times, with the school day advanced by up to 90 minutes (to get ahead of the morning work peak), and a corresponding finish in the early afternoon; it was described to respondents as a Continental European school day, and a few of them were already aware of similar proposals for Adelaide. Not surprisingly, this radical change in institutional constraints resulted in some significant restructuring of household activity patterns and tended to produce both larger benefits and disbenefits than the proposal to retard school hours by 30 minutes; the main effects are summarised in Figure 7.

General attitudes towards the proposal varied according to whether respondents felt more comfortable with earlier or later starts to the day. The prospect of starting school at 07.30 a.m. came as quite a shock to some people:

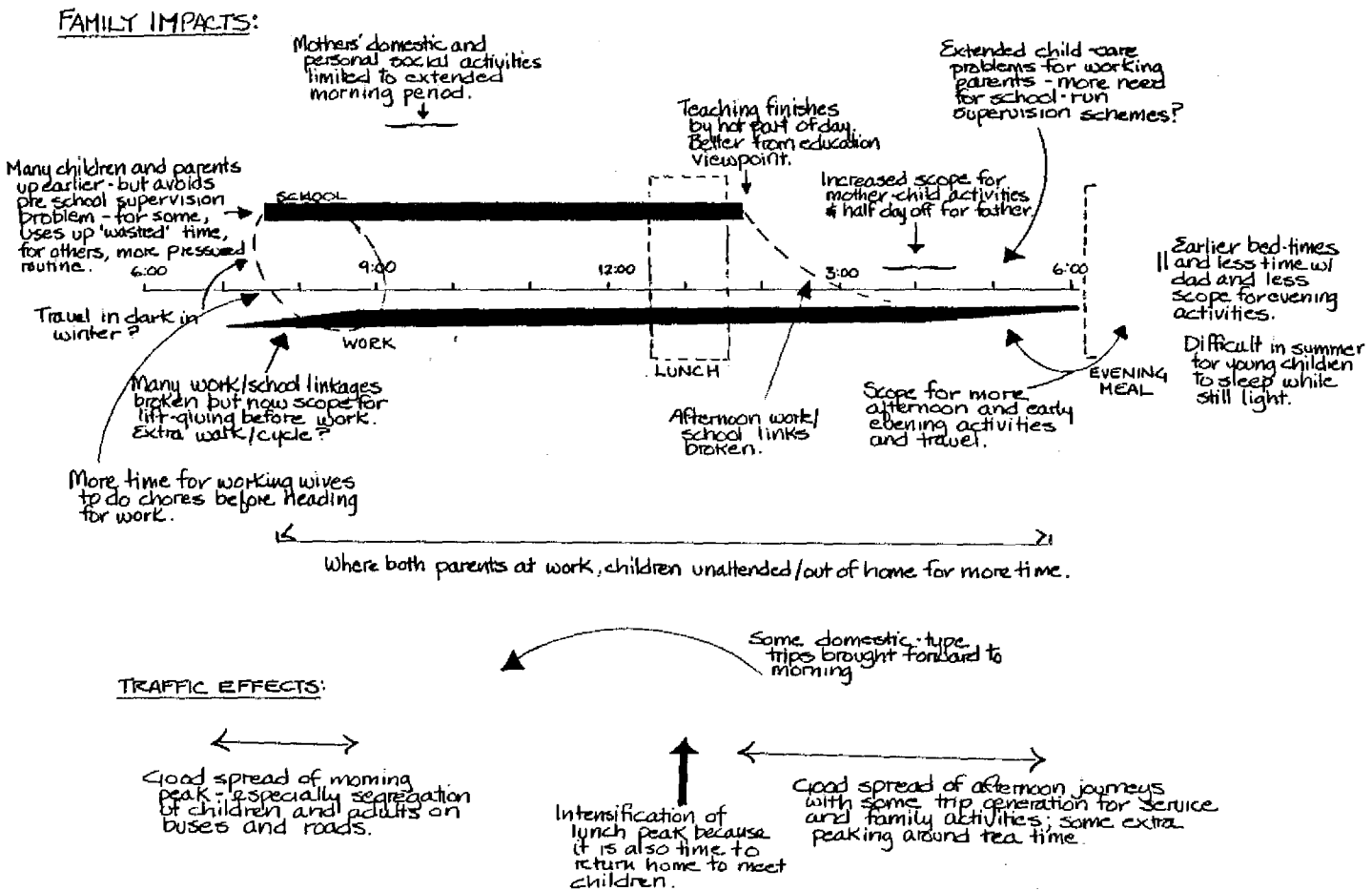
> "That wouldn't suit this household at all - it's crowbar time at 7.30 a.m.!"

while others felt it would do away with 'wasted' time at the start of the day - some families were already up before 7.00 a.m., either because of the work hours of parents or simply because they were early risers, and some children were filling in time by watching television or reading

Many respondents immediately recognised the knock-on effects on earlier evening bed times for children. There were worries whether this would be feasible for younger children in summer, who would be unlikely to settle before it got dark and would then be half asleep the next morning. If work hours were unchanged, it would also mean that working parents - especially the fathers - would have less time to play with their children during the week.

The effects on morning travel arrangements would be complex and variable. Where parents went to work early in the morning the earlier school start would avoid children being left unattended at home and would enable some parents to drop children off - even if it meant deviating from their route. For those with a later job start, however, the linkage would be broken and either a special chauffeuring journey would have to be made to/from school, or the children would make their own way there on foot or by cycle or bus; given traffic would be lighter at those times, this would probably be more acceptable, although there were worries about children being allowed to make their own way to school in winter in the dark.

Figure 7: Some Consequences of Earlier School Hours



It was in the afternoon, however, that the major consequences of an earlier school day would be felt. All recognised the eductional benefits of finishing before the heat of the day in summer, but there were strong pros and cons as regards how the rest of the afternoon would be spent.

For working parents, there were worries about how children would cope being left unattended for an extended period in the afternoon, and indeed whether it would still be feasible for some mothers to have a part-time job. Some schools already have after-school recreation programmes to 6.00 p.m. to cover for working parents, and it was hoped that such programmes would be implemented more widely by the community as part of a general move towards an earlier school day. If this happened, it would actually help to reduce the problem of 'latch key' children.

Non-working mothers would experience more of a polarisation in their day, with a longer period in the morning free for domestic-type activities and a larger block of time for social/recreational activities with children after school. Two possibilities were recognised here:

(a) Extra activities in the afternoon:
> "A whole load of things could get done. We can never (at present) find the shopping hours to get children's clothes; you can't get them to the dentist or doctor's, because you can't get them there before school, and after school that one and a half hours just isn't enough - we've got music, gymnasium, tennis - there's always something filling it up."

(b) Rearrangement of activities to provide more free time in the evening:
> "Probably they would get their homework done earlier and we'd perhaps go out to visit people, and we'd still be home early enough for them to go to bed."

Among husbands who worked on flexi-time, there were also suggestions that a substantially earlier school day might encourage them to take off extra blocks of time during the week, to spend half days with their children.

In traffic terms, the earlier school day is the better solution in respect of first order effects, since both the morning and afternoon peaks became much more spread - although there are dangers of the earlier afternoon school peak impinging on late lunchtime peaks in traffic.

Many parents thought that these benefits could be realised by a slightly later, 8.00 a.m. start to the school day, which they felt would be much less disruptive to family routines.

When taking account of second-order effects, however, the benefits are likely to be significantly reduced, since:

(i) The early school start will lead to fewer school-work linked trips, but many of these might be replaced by pre-work two-way serve passenger trips, so increasing traffic volumes and energy consumption (especially in winter, when parents may be unhappy about their children walking or cycling to school in the half light).
(ii) The long period of uncommitted time in the afternoon, between school and the evening meal, may encourage parents and children to take part in extra non-home activities, thereby still creating a child-generated traffic peak around tea time.

Aggregate Implications

In an attempt to assess the likely impact of the introduction of an 8.00 amschool day policy on aggregate traffic profiles in Adelaide, a temporal re-structuring was undertaken of trip profiles for car, walk/cycle and public transport travel using the 1977 MADBS data, on the assumption that the types of responses reported in the HATS interviews would be adopted by residents throughout the Metropolitan area.

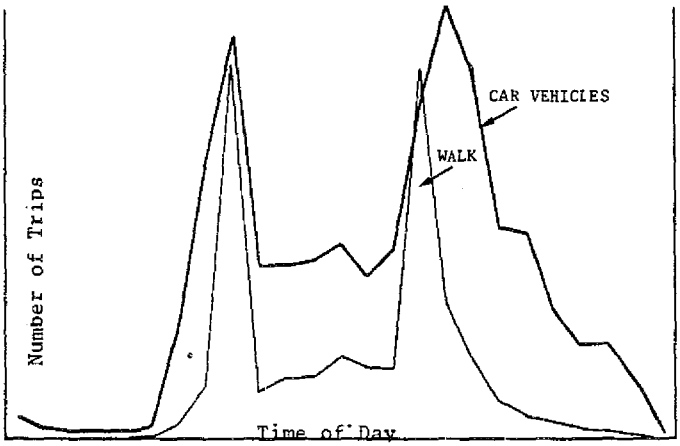
Figure 8 summarises the main results for car driver (equivalent to car vehicle) and walk/cycle modes (the latter almost entirely comprising journeys to/from school). Under the conventional school hours (Figure 8a), there is a complete coincidence of walk/cycle and car vehicle peaks in the morning, resulting in considerable vehicle/pedestrian conflict and delay to all travellers; the afternoon peak is a little more staggered. If school hours were advanced by one hour and this had the effect of shifting only walk/cycle trips (as in Figure 8b), then the morning peak clash would be reduced and the afternoon conflict would be eliminated.

However, there are four types of change in travel behaviour resulting from school hour revisions that need to be considered:

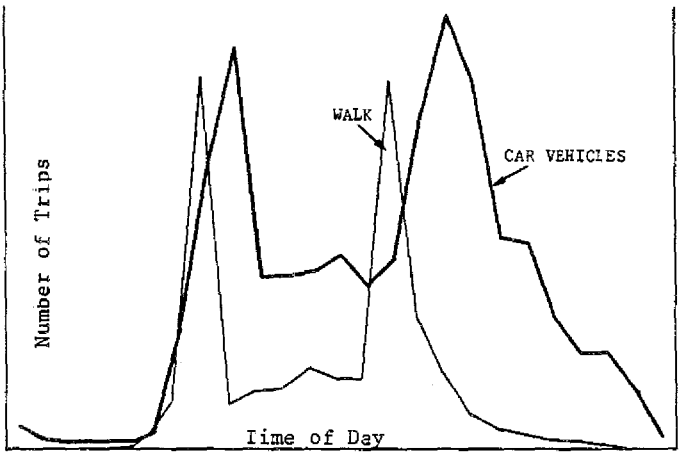
(i) Changes in journeys to/from school by children
(ii) Effects on parents who chauffeur children to/from school
(iii) The other journeys made by school children during the day
(iv) Other journeys made by adults during the day.

Figure 8: Effects of School Hour Change on Temporal Patterns of Travel

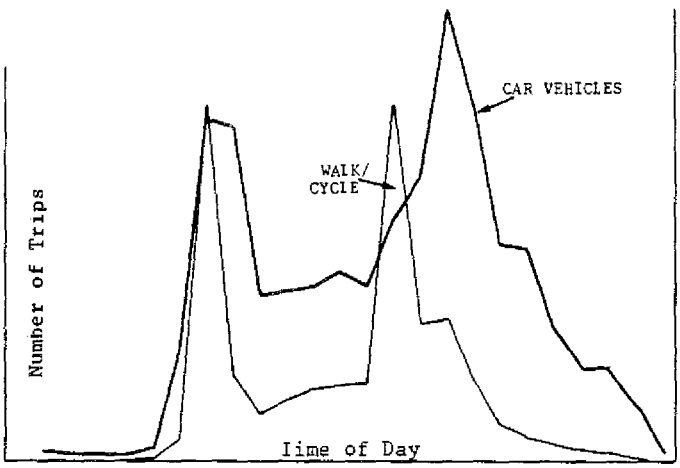
(a) Existing Relationship Between Walk/Cycle & Car Vehicles



(b) Effect of One Hour Shift in Walk/Cycle Only



(c) Full Effect of a One Hour Advance in School Times



When we allow for changes in travel behaviour at the household level, making certain assumptions about the proportion of the population who would respond in different ways, we derive the revised temporal profile shown in Figure 8c. Although the morning peak level of car driver traffic has been reduced and spread in time, we see that the motorised/non-motorised mode clash has not been resolved by the earlier start to the day. There is a better separation in the afternoon, but in the morning the shift forward of the car serve-passenger trips to school coincides with the early work journeys and means that the peak travel time has shifted forward with the advance in the school day. This tends to confirm the realism of the assumption made when selecting the policy options for the HATS interviews, that a one and half hour shift forward in the school day would be necessary to secure real benefits here.

5. POLICY ASSESSMENT

The objective of the Stage I exploratory work has been to demonstrate the sorts of policy issues which can be tackled using in-depth, activity-based survey and analysis procedures, rather than to provide definitive policy advice, and the conclusions drawn here should be viewed in that light. Despite the small sample size in the HATS interviews, however, it has been possible to examine some of the insights from these interviews using the ATDAIAS survey data and to corroborate some of these findings with reference to studies in other countries.

Peak-Spreading Policies

The aspect of the work of primary policy interest concerned respondents' reactions to the various peak-spreading options. On balance, it seemed that both earlier work and school hours were preferred to moving either later (with slightly more people opting for an earlier school day), and that later school hours were slightly more unpopular than later work hours. Apart from personal preferences, responses seemed to be affected by the nature of the employment, whether the wife was employed, and the age of the children. Given a larger sample and a more structured approach (along the lines proposed in Stages II and III of this study, and outlined in section 6), then it should be possible to identify clear preferences among sub-groups of the population.

What this exploratory work did highlight, however, was the diversity of factors which entered people's assessment and response to options and the difference in priorities among members of the same households. Not only are there pros and cons to each policy, but there are also different distributions of costs and benefits which impinge differently on the various household members. Each household thus found itself making trade-offs between its members, as well as in some cases considering the effects on other groups in the community.

One consistent preference which did emerge was for the use of institutional changes to tackle traffic congestion (i.e. through modifications to work or school hours), rather than by introducing some form of peak pricing. In all cases where road pricing or peak public transport surcharges were discussed, the possibility was viewed as the least preferred option for Adelaide, both because of a dislike of the idea in principle, and because traffic congestion was not seen as serious enough to warrant such options. This is where a school hour policy scores, because many of the respondents who did not feel congestion was bad enough to contemplate the implementation of any peak-spreading policy did acknowledge that there were local safety issues arising from exposure of children to peak traffic levels and so were willing to consider school hour changes for this reason.

Figure 8 dealt only with the temporal profile of travel at the Metropolitan level, but when we look more closely at different areas of the city, we find that work/school trip conflict shows marked spatial variation. In most industrial areas employees are at work well before the school traffic builds up, and in the outer suburbs office workers leave ahead of peak school flows; for such areas the imposition of a blanket change in work or school hours could exacerbate existing traffic problems.

Given these various factors, the balance of advantage would probably lie with changing school rather than work hours, for the following reasons:

(i) School catchments are generally more localised than work ones, so that shifts in time profiles can be better 'tuned' to local conditions than if work hours were changed.

(ii) Schools operate largely independently of one another, so that hours could be varied between schools without significant linkage problems - except, possibly, for some mothers who are teachers. We identified some significant linkages between industrial sectors, however, which would be affected by a selective change in work hours.

(iii) In practical terms, it would probably be much easier to bring about changes in school than work hours, because the institutional arrangements for the former are more directly under government influence.

(iv) A smaller proportion of the population would be affected directly by school hour than work hour changes, though certain benefits would be enjoyed by all peak period travellers.

With most of the peak-spreading policies, there were caveats attached to the responses, which need to be considered as an integral part of the package. In particular:

(a) To gain general public acceptability for a substantially earlier school day, there would have to be some community-based facility for afternoon child supervision to cover for families where both parents were at work.
(b) If peak road pricing were introduced in Adelaide, its acceptability would be greatly enhanced if it were seen as part of a package of public transport improvements and further relaxation of the timing of hours of work.

Other Aspects of the Study

Although less directly policy-oriented, other aspects of the study have produced findings that have important policy implications. In section 3, for example, we outlined a number of techniques to examine day-to-day variations in behaviour, which confirmed that it is the peak journeys which are also the most frequent and regular, whereas off-peak travel is carried out infrequently. There are thus substantially different travel markets in the peak and off-peak, in terms of familiarity with the journey and rapid absorption of new information. This has implications, for example, for the ways in which details of revised bus services might best be disseminated to customers, or for the type of road safety campaign that might be targeted at peak and off-peak travellers.

We were also able to provide useful information about attitudes towards STA bus services, and the effects on travel of company car ownership and use, as an adjunct to the main purpose of the study. Taking the latter, for example, there is little doubt that the possession of a company car affects both household travel behaviour and the level of car ownership in the household. Nobody in our sample with access to a company car even considered the possibility of using public transport, and in most cases drivers were largely immune to the costs of motoring - in some cases even parking fines were paid by the company.

6. STAGES II AND III OF THE STUDY

The objective of Stages II and III, building on the Stage I work, is to develop a set of practical activity-based analysis and survey tools that can be used by staff of the South Australia Department of Transport to examine relevant transport issues, both through the interrogation of existing data sets and the collection of additional information. Work will concentrate on the development of two planning tools:

(a) An interactive analysis package that can be used to interrogate trip-based or activity-based data sets and provide information about various aspects of household activity/travel patterns in Adelaide.
(b) A new survey technique, which identifies household responses to certain policy options and measures the preferences and priorities of individuals and households.

The project is scheduled for completion in late 1986.

Interactive Analysis Package

Conventional analytical techniques now available to the Department are generally not flexible enough to cover the types of analyses that are needed to support the activity approach. Once one starts to look at travel behaviour in this new way, cross-tabulations and similar outputs are not able to provide the kind of detailed evidence of temporal linkages and constraints which is required in order to be able to examine relationships on large datasets.

The activity-based analysis package will incorporate features illustrated in this paper and will provide the following facilities:

- flexible specification of the outputs, giving a wide choice of presentational formats and types of display, with the option to save output on the computer for subsequent processing by other programs
- interactive capability, so that analyses can be tried on the VDU screen, amended at will, and printed if required.
- the ability to select sub-groups of the sample population, defined according to demographic variables or according to observed behaviour.
- an hierarchical database designed so that analyses may be carried out at household, person, activity or trip (or stage) level
- a modular structure so that development may take place in stages, and new modules may be added as required
- a degree of 'intelligence' so that specific behaviour features (such as linkages between persons, car usage arrangements) may be analysed directly.

This type of analysis is best suited to activity-diary datasets, but given the necessarily limited sample size that these provide, it is desirable to be able to use the package with a more conventional trip-based dataset - the activities which give rise to the observed trips being inferred from the available data. Specifically, the package will be designed to take advantage of the small-scale but detailed ATDATAS activity dataset, the larger, travel-based, 1977 MADBS and a proposed 1986 travel survey in Adelaide.

Activity-Based Survey Technique

The second major area of work will involve the development of a new survey technique that is able to explore people's responses to proposed policies and identify their preferences and trade-offs, in the context of household activity-travel patterns. In order to achieve this objective, we will draw on and integrate two types of survey methodology that hitherto have been used separately

First, the HATS-based approach, which examines travel behaviour explicitly in terms of household activity patterns and is able to identify constraints on behaviour and to trace some of the wider ramifications of policy measures on people's lives; its main limitations, however, are that it is only suitable for small scale, exploratory work and is not able to measure respondent's preferences in a very rigorous way. The second methodology which we will draw on involves the use of "stated preference" techniques, to measure people's preference structures and their intended responses to different policy options; quantifiable results can be obtained using such rating or ranking procedures, but the techniques have been criticised for being too hypothetical, with few checks on the realism of the responses obtained.

The activity-based survey package will aim to combine the best elements of both approaches and embody the following features:

- examination of travel behaviour in the context of daily activity patterns;
- tailoring of options used in the stated preference exercise to the specific circumstances of each individual;
- allowing for the possibility that reactions to elements of the policy options may be non-compensatory and non-linear, and that threshold points may exist with respect, say, to tolerable fare levels on public transport;
- provision of a framework within which respondents can systematically explore their responses to different policy options, before being required to make judgements about which they would prefer;
- use of procedures for rating or ranking options, including a 'do nothing' option;
- experimentation with the use of portable computers in the home to help in:
  (i) the design of person-specific options
  (ii) checking on the realism and consistency of responses to the different options.

It is likely that the case study will look at the effects of car restraint on household activity-travel patterns.

7. ASSESSMENT AND CONCLUSIONS

The main purpose of the first stage of the study of household activity-travel patterns in Adelaide was to demonstrate the sorts of issues that could be addressed using activity-based techniques, rather than draw definitive conclusions. Indeed, the project is designed primarily to develop methodology for addressing policy issues rather than being a one-off study to answer a specific question. Nevertheless, there is a clear policy relevance in the work completed to date.

In Stage I we have shown some of the benefits of studying travel in the broader context of household activity patterns, using a combination of qualitative and quantitative approaches in an integrated way. Both the range of impacts that can be examined and the forms in which they are measured tend to be much broader than is the case with most trip-based approaches - although, of course, for many purposes the type of information obtained by using the latter procedures is perfectly adequate. We have also tried to link the micro and macro aspects of analysis, whereby complex processes or patterns can be understood at an individual level and then examined in more aggregate fashion across the population as a whole.

The major benefits of the study will become evident after completion of Stages II and III of the work, when practical activity-based techniques will be available for use by the Department to address a range of issues. Nevertheless, some of the advantages of adopting an activity perspective have already been realised; in particular, it encourages a reorientation of the way in which transport problems are perceived, and policy options are generated and evaluated, and enables practitioners to think along lines that would be difficult to explore using most existing transport planning aids.

Inevitably, in an exploratory study of the type reported here, there are many issues which are raised that cannot be taken up in the course of the work. This relates as much to research as policy questions. As an example of the latter, in the course of our work we have been concerned with the difficulty of defining an appropriate basic behavioural unit for studying travel behaviour: we need both a household- and individual-based unit. Stage in family life cycle has served as a good proxy, but it is difficult to delimit boundaries between some of the groups and with changing social patterns households are exhibiting a greater variety of structures. The long-term solution may lie in a flexible classification of household 'living units', with characteristics built up from a knowledge of the needs, preferences and constraints of members of the group, but in the short-term the problem can be met by developing tools that can be applied using a range of behavioural units - ensuring that procedures are as flexible as possible.

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