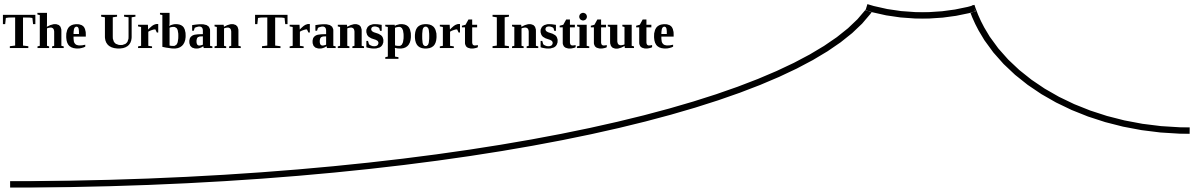
The Urban Transport Institute



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The Influence of Mobile Communications on Activity and Travel Scheduling

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1. Introduction

In much of the research on activity scheduling, there is a distinction drawn between “planned” and “spontaneous” activities. Furthermore a sequence of planned activities spread over time may often be thought of as part of an overall “project”. In an era of rapid deployment of mobile communications (mobile phones, SMA devices, smart PDAs etc), the distinction between planned and spontaneous activities may not be so clear-cut. The use of mobile communications can give rise to many situations in which spontaneous activities are created as a result of a communication episode, even though that activity might be part of a larger overall planned project.

This exploratory paper will consider some of the issues surrounding the possession and use of mobile phones (we will use the Australian terminology of "mobile phones", although the same devices are called cell-phones in America and Handy-phones in parts of Europe), the way in which communication activities are related to travel activities and the issues that are likely to arise in the design of data collection programs and in the analysis of the resulting data, when proper attention is paid to the role of mobile communications in the activity scheduling behaviour of people, especially those who are heavy users of mobile communications.

2. Some Scenarios

Consider the following possible scenarios of interactions between mobile phones and travel:

> "Malcolm and Helen have been planning a dinner party for some weeks. On the night of the dinner party, as Malcolm prepares the meal he realises that they are short of some wine to go with the dinner. He makes a mobile phone call to Helen who is already driving home from work. This causes her to make a detour to pick up a few extra bottles of wine. Is this extra trip a "spontaneous" trip or is it a "planned" trip as part of a larger "planned" project?"
>
> "Sam and Janet have gone to separate meetings in the city. They plan to meet up at a street corner after their meetings and drive home together. Janet's meeting runs over-time. She calls Sam on his mobile phone, and tells him to drive home alone and she will get a taxi later. In this case, the mobile phone has increased the number of vehicle trips, reduced the waiting time (for Sam), and changed one planned trip into two spontaneous trips."
>
> "Sue is a teenage girl who likes to go night-clubbing. Jack is her worried father. He is not worried about the night-clubbing, but rather the trip home

later at night (early next morning). Sue is not licenced to drive, but there is a good tram service from the night-club area to about half a kilometre from her home. Jack is worried about the walk home from the tram stop. Rather than stop Sue from going to the clubs, Jack buys her a mobile phone on the condition that she phones him on the way home on the tram so that he can pick her up and drive her home. Sue gets to go clubbing, Jack's mind is at ease. The mobile phone has enabled the planning of the trip home in a way that would not have been possible without the mobile phone."

"Ellen and Andrew both work and have a 4-year-old daughter Rosalie who is in pre-school care during the day. Pre-school ends at 4.30pm and kids must be picked up by 5pm sharp, otherwise financial penalties are imposed by the pre-school (to pay for teachers waiting until all kids have been picked up). Because of the nature of their jobs, Ellen and Andrew never know whether they will be forced to work a bit late. Therefore, while there is a long-standing plan for one of them to pick up Rosalie before 5pm, they never know who it will be until their regular 4.30pm mobile phone call to work things out. If neither of them can make it, they reluctantly phone Ellen's mum, who lives near the pre-school and who can walk across to collect Rosalie. The mobile phone enables a spontaneous decision to be made within the context of a long-term activity schedule."

"Mick and Bruce both love Australian Rules football. In the days before mobile phones, they lived near each other and used to car-pool to the footy together. Since then they have moved houses, but Mick used to still go round to Bruce's house to pick him up (a detour of over 10 kilometres) to go to the footy together. Since both getting mobile phones, they now go separately to the footy (Mick still drives but Bruce takes the bus), and when Bruce gets to the football ground (where the crowd is often over 70,000), he phones Mick to find out where he is seated, so they can watch the game together. Depending on what Mick is doing after the game, he sometimes gives Bruce a ride home in his car. The mobile phones have changed one planned car-pool trip into a planned car trip and a planned bus trip, and an occasional spontaneous car-pool trip".

The above scenarios have illustrated just some of the ways in which the rise of mobile phones has changed the way in which we travel and interact with other people. If we are to fully understand the impact of mobile phones on travel patterns, and the ways in which mobile phones affect the scheduling and re-scheduling of activities and travel, we need to explore these interactions more closely.

3. The Possession and Use of Mobile Phones

While mobile communications, especially mobile phones, are becoming an increasingly ubiquitous item of apparel in Western society, relatively little factual information is available about the demographics of the users or about the way in which mobile phones are used. There are clearly mountains of information collected about mobile phone users and the use of mobile phones, since telecommunications companies need such information for billing purposes. Undoubtedly, such information is also used for market research purposes within the telecommunications company. However, because of the extremely competitive nature of the telecommunications industry, little of this information is publicly available.

Mobile Phone Ownership Rates

There are, however, some relatively aggregate statistics about mobile phone ownership and use that give an indication of the scale and penetration of mobile phones. The following table of mobile phone ownership rates in different regions of the world has been gleaned from various web sources, especially the International telecommunications Union website (www.itu.int) (the figures are indicative only and may refer to slightly different time periods using slightly different definitions).

Table 1 Mobile Phone Ownership by Region

Region	1995 Mobile Phones (millions)	2001 Mobile Phones (millions)	Annual Growth Rate (1995-2001)	2001 Mobiles per Capita
Western Europe	22.7	276.3	52%	0.72
Eastern Europe	1.4	74.1	93%	0.18
Africa	0.6	23.5	82%	0.03
Middle East	0.9	15.8	60%	0.09
Central Asia	3.8	154.2	85%	0.06
South East Asia	18.4	166.6	44%	0.23
Australasia	2.6	13.6	32%	0.58
Oceania	0.0	0.2	66%	0.03
North Americas	36.4	136.9	25%	0.43
Central Americas	1.2	29.3	71%	0.17
South Amercias	2.7	55.7	66%	0.16
TOTAL	90.7	946.3	48%	0.16

It would appear that mobile phone ownership is highest in Western Europe, followed by Australasia and North America. However, it should also be noted that the countries with the highest ownership rates are in South-East Asia (Taiwan and Hong Kong). The annual growth rate is generally very high, especially in those regions with low current ownership rates. Thus while mobile phones were about equal in number to fixed phones in 2001, their high growth rate means that they will soon outstrip

fixed phones on a global basis (indeed they probably already have by the time this paper was written).

Demographics of Mobile Phone Owners

The demographics of mobile phone users are even more sketchy than the ownership rates, but some trends are becoming apparent in several countries. As shown in Figure 1 for the USA (www.upoc.com), mobile phone ownership tends to rise then fall with increasing age. The highest levels of ownership appear to be for people around 30 years of age.

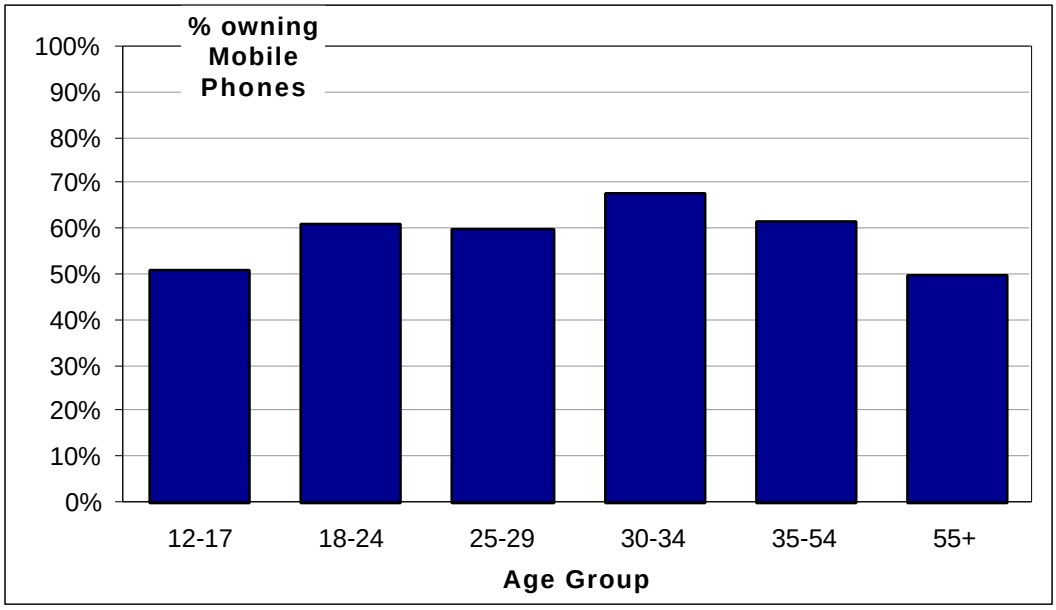

Figure 1 Mobile Phone Ownership by Age in the USA

This same pattern is repeated using data for Japan (Video Research Ltd., www.ddd.com.jp), as shown in Figure 2. Despite the overall level of mobile phone ownership for people over 12 being higher in Japan (70%) than in the USA (60%), a similar trend with age exists. However, since the Japan data also contains ownership rates by gender, another trend emerges. Young women are more likely to have mobile phones than young men, while older women are less likely to have mobile phones than older men.

The differences in mobile phone availability can be observed from a slightly different perspective using data from a recent survey in Melbourne, Australia. This survey was a roadside intercept survey of motorists driving exposure, and as part of the interview they were asked whether they had a mobile phone with them at that time. The results of this survey, by age and gender, are shown in Figure 3. The fall in mobile phone possession with increasing age is apparent. In addition, women under 25 were more

likely to have a mobile phone with them than men of the same age. However, unlike the Japanese results, women over 60 in Melbourne were also more likely to have a mobile phone with them than men over 60.

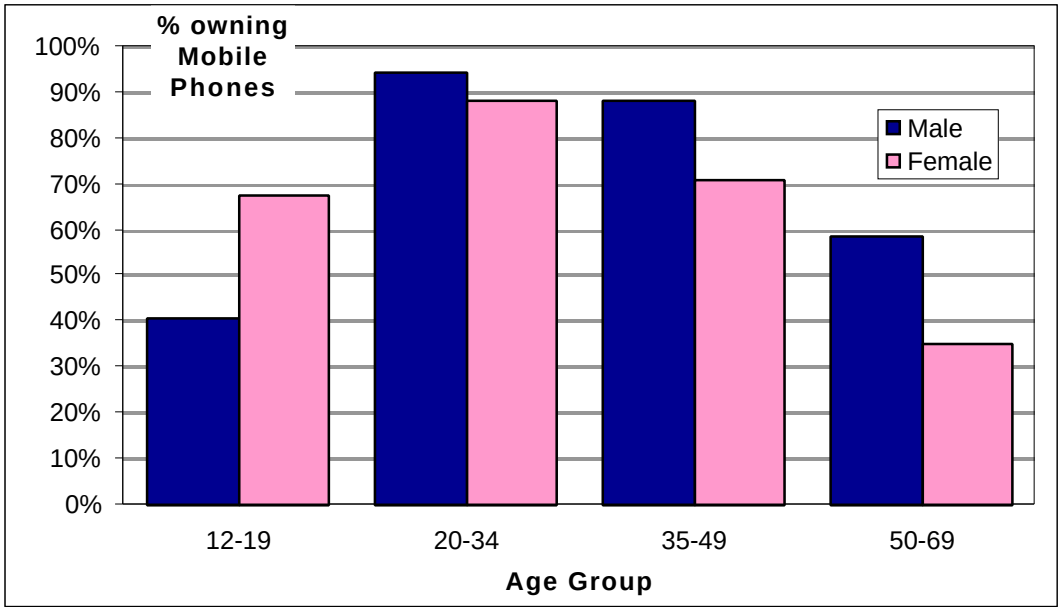

Figure 2 Mobile Phone Ownership by Age and Gender in Japan

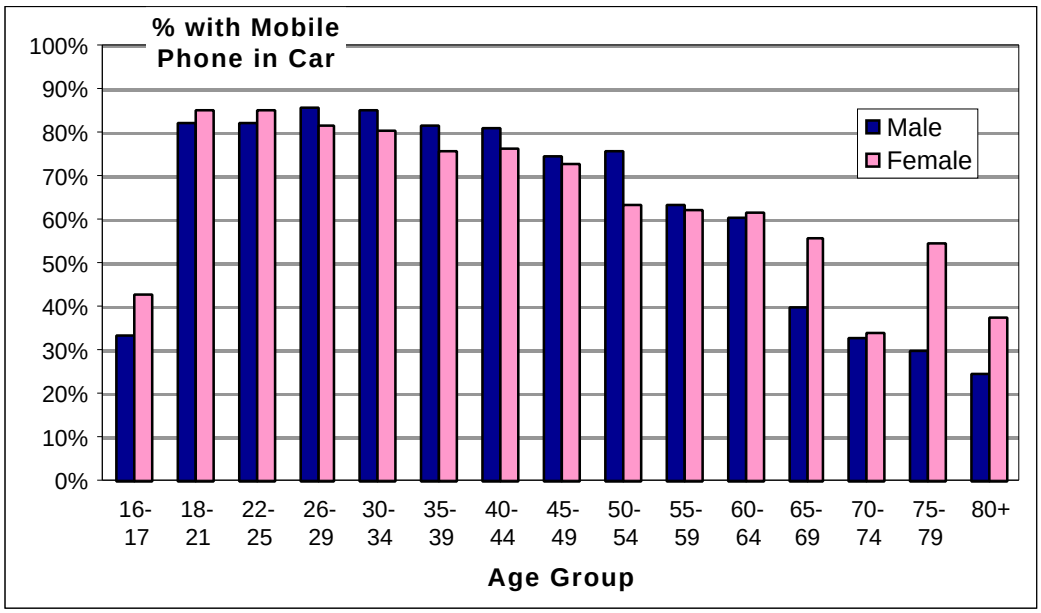

Figure 3 Mobile Phone Possession in Car by Age and Gender in Australia

It should be realised, however, that the results in Figures 2 and 3 are not totally comparable. Figure 2 refers to ownership of mobile phones while Figure 3 refers to possession of a mobile phone while driving. It could be argued that the real phone ownership rate is higher than shown in Figure 3, since some people may have left their mobile phone at home. On the other hand, it could be argued that Figure 3 is an

over-estimate of the mobile phone ownership of the population, since car drivers are probably an atypical sample of the population with respect to mobile phone ownership. Nonetheless, the major point to emerge from Figure 3, with respect to the possible influence of mobile phones on travel and activity scheduling, is the fact that about 80% of all drivers between the ages of 18 and 45 have a mobile phone with them while driving.

This point is emphasised further by the results in Figure 4. In addition to asking whether the driver had a mobile phone with them, they were also asked whether it was switched on. 89% of males who had a mobile phone with them and 77% of women who had a mobile phone with them had them switched on at the time (despite the fact that in Australia, like in many other places, it is illegal to use a hand-held mobile phone while driving!). The propensity to have the phone switched on tended to decrease with age, as shown in Figure 4.

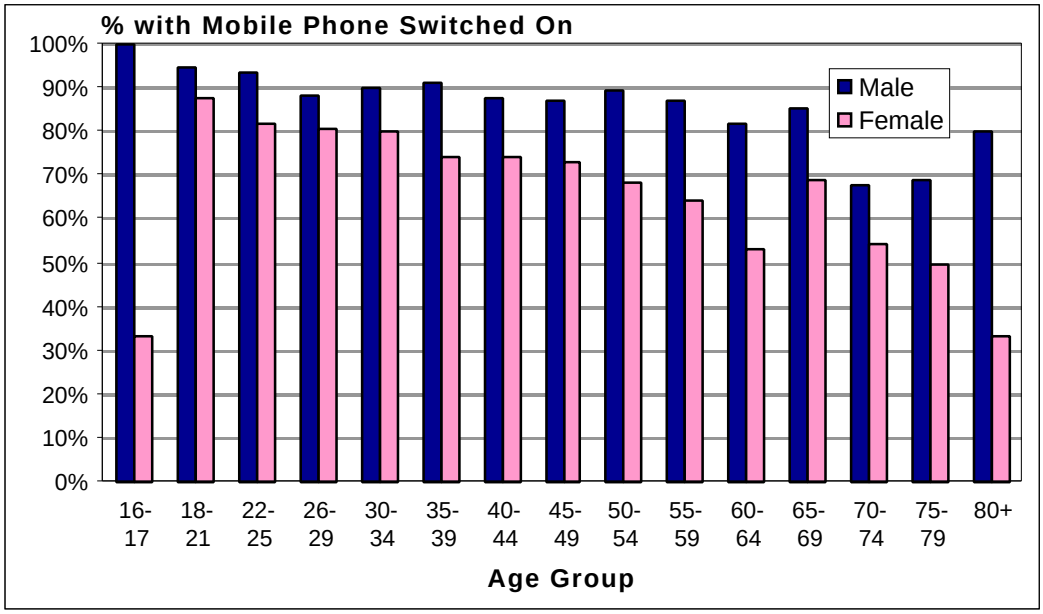

Figure 4 Mobile Phone Switched-On in Car by Age and Gender in Australia

The results in Figures 3 and 4 can be combined to show, as in Figure 5, the overall proportions of all drivers (by age and gender) who have a mobile phone in the car switched on and ready to make or receive calls. This proportion of drivers are all susceptible to having their travel and activity schedules disrupted by the use of the mobile phone. 70% of male drivers and 58% of female drivers are in this situation.

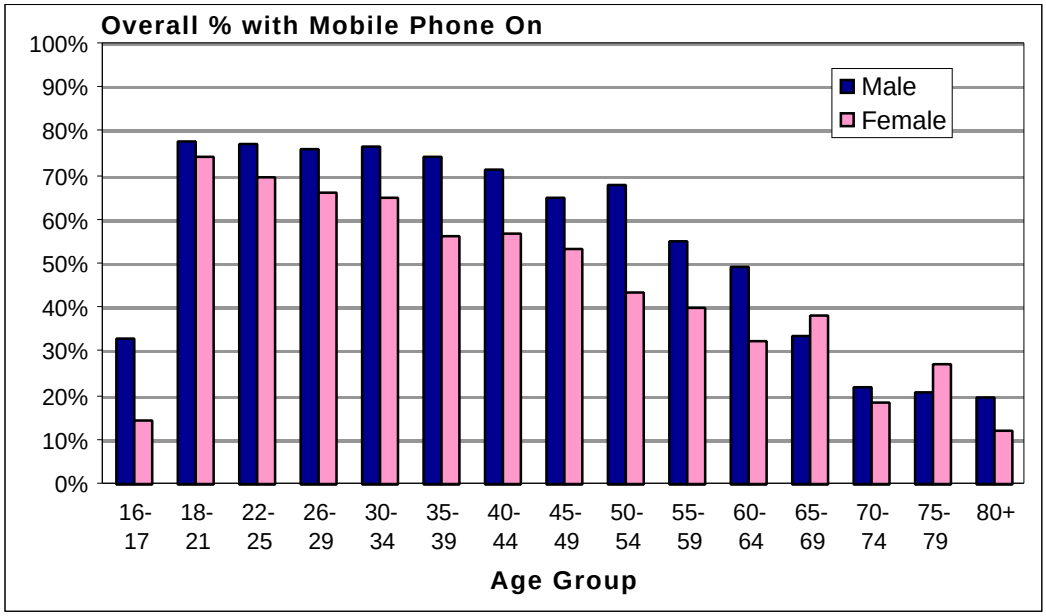

Figure 5 Overall Proportions with Mobile Phone Switched-On in Car

Usage of Mobile phones

If information about the demographics of mobile phone users is sketchy, then solid data about mobile phone usage is even more scarce. An exception to this is the Japanese data quoted above (Video Research Ltd.) which also contains some interesting facts about mobile phone usage. The overall levels of usage are shown in Figure 6, where it is seen that the most frequent usage level is one or two calls (in or out) per day. Some users hardly use their mobile phone at all (less than once or twice per week), while others use it extensively (more than 10 calls per day).

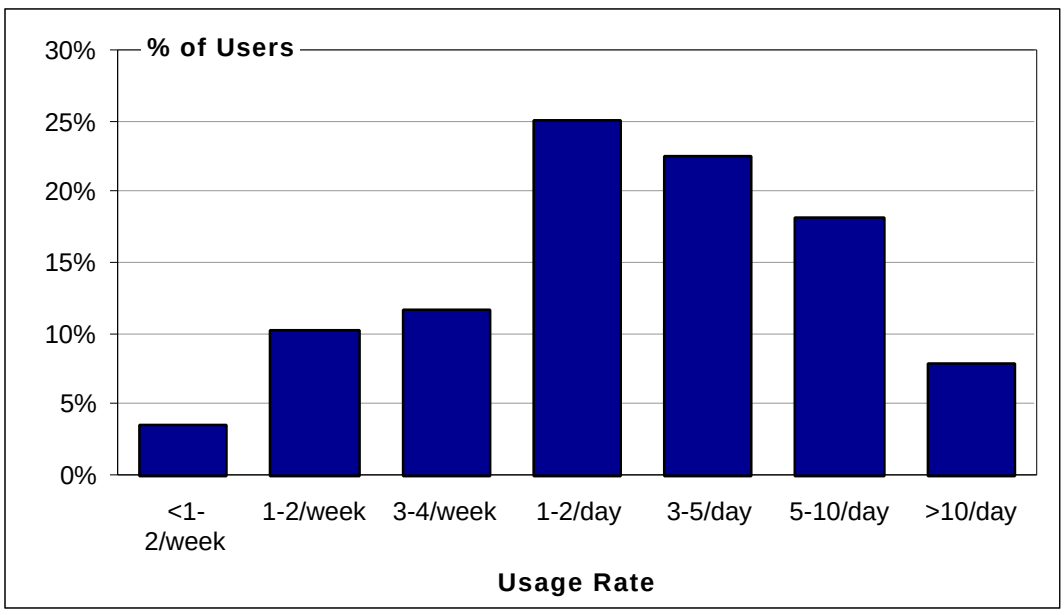

Figure 6 Mobile Phone Usage in Japan

The characteristics of the heavy users (more than 5 calls per day) are shown in Figure 7. It can be seen that men (in Japan) are heavier users than women at all ages, and that people in their twenties and early thirties are the heaviest users.

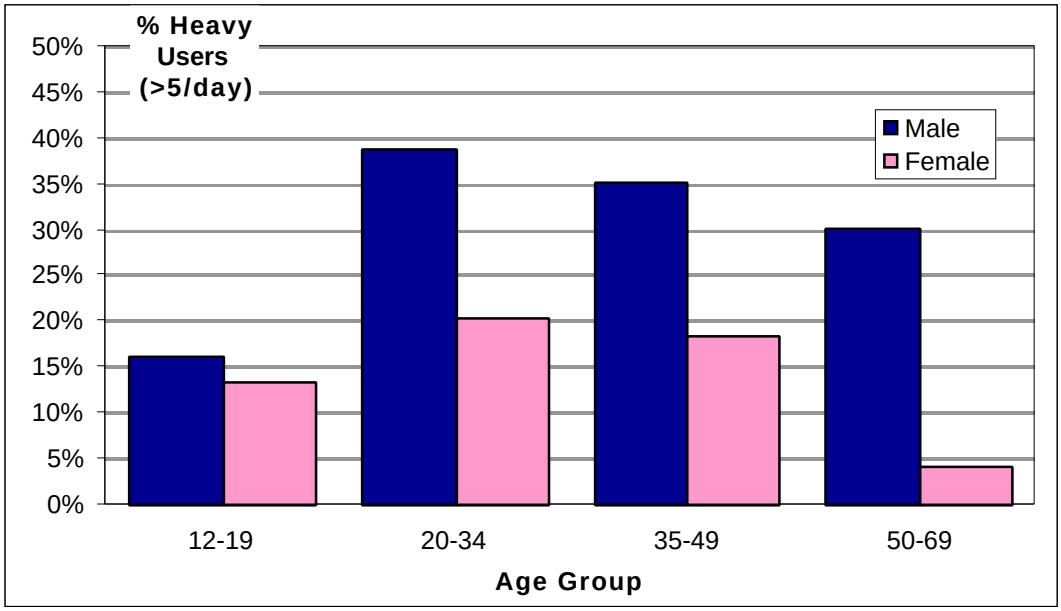

Figure 7 Mobile Phone Heavy Users by Age and Gender in Japan

The reasons why people make mobile phone calls is shown in Figures 8 through 10. It can be seen in Figure 8, for example, that people under 35 (especially teenage boys) tend to use the mobile phone for making calls to friends.

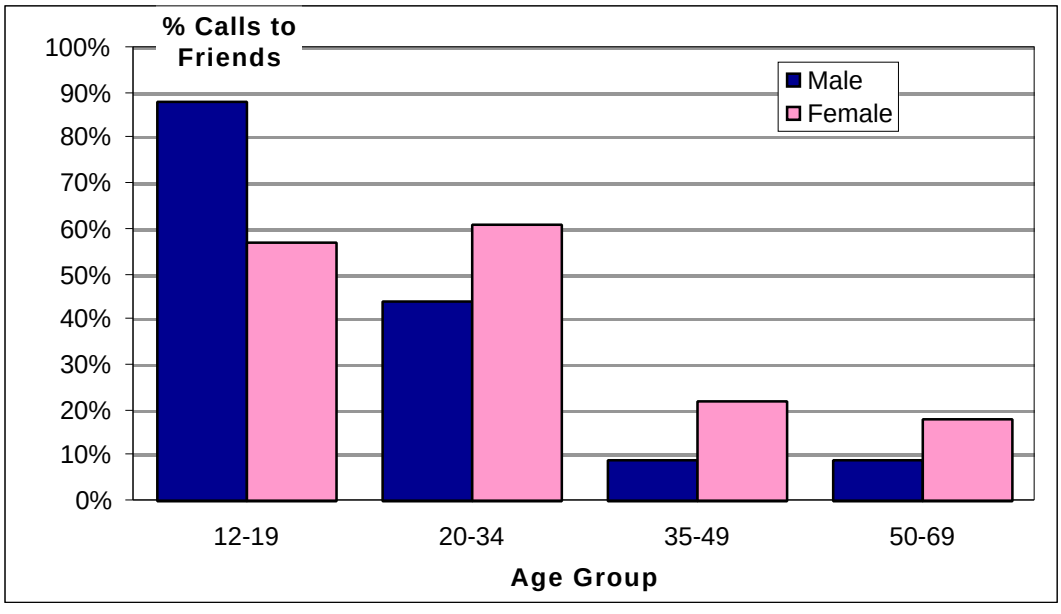

Figure 8 % Calls to Friends by Age and Gender in Japan

On the other hand, it can be seen in Figure 9 that people over 35 (especially women) tend to use the mobile phone for making calls to family members. Indeed women at all ages tend to make more of their calls to family members than men make calls to family members.

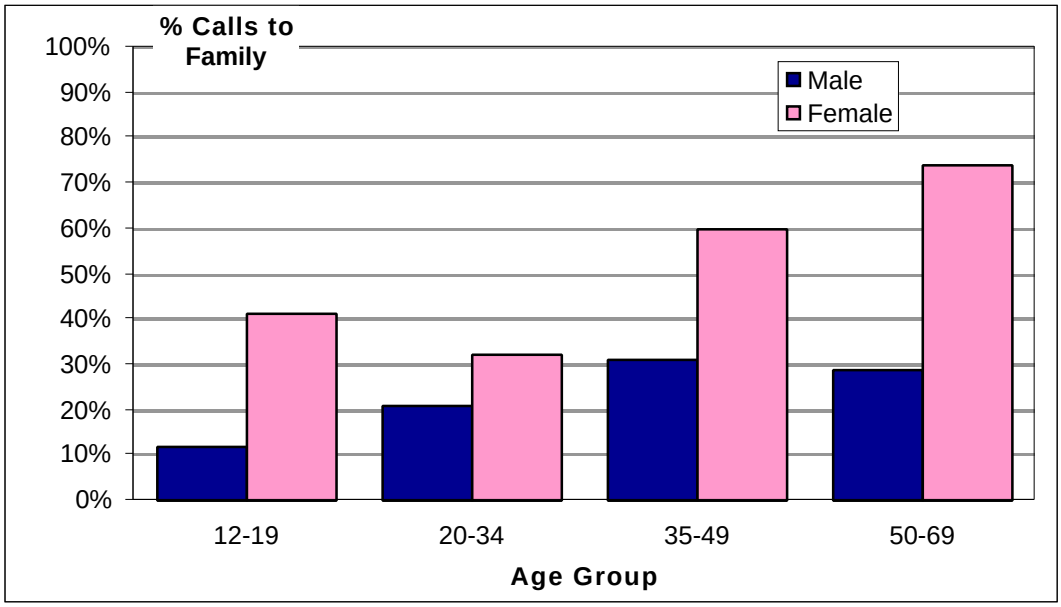

Figure 9 % Calls to Family Members by Age and Gender in Japan

However, it can be seen in Figure 10 that men (in Japan) tend to dominate the use of the mobile phone for making business calls, especially for men over 35.

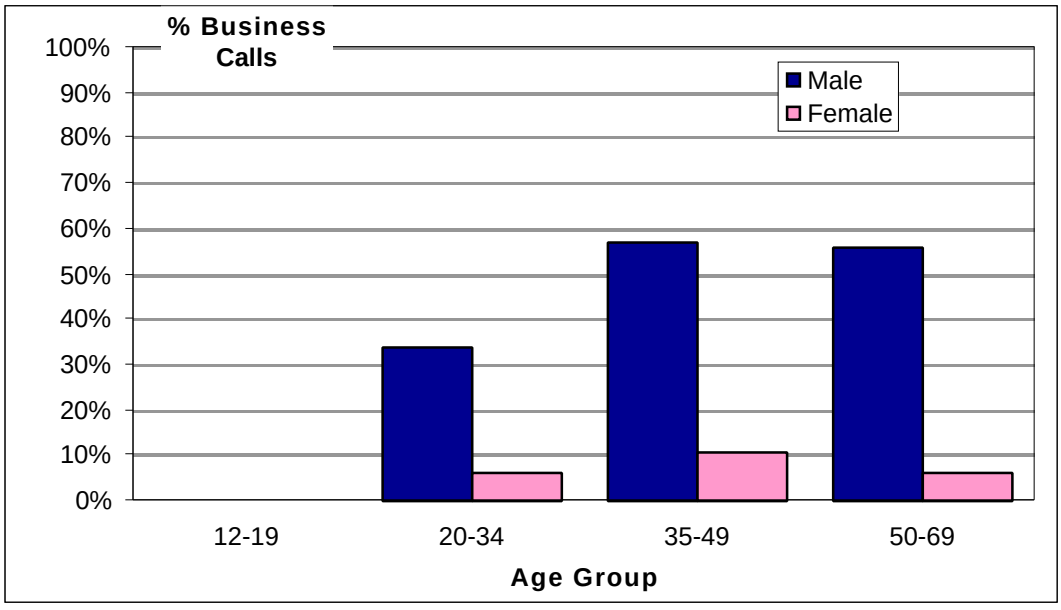

Figure 10 % Business Calls by Age and Gender in Japan

The place where calls are made (or received) is shown in Figure 11. In line with the nature of a "mobile" phone, relatively little use is made of mobile phones at home (although more and more people are starting to have a mobile phone as their only phone). The largest proportion of calls are made from a place which is neither home nor work (such as from a shop, or in some other public place). About 10% of all calls are made from a car, and about 3% from public transport. It can be seen that males are more likely to use a mobile phone at work or in the car, while females are more likely to use the mobile phone at home or in some other public place.

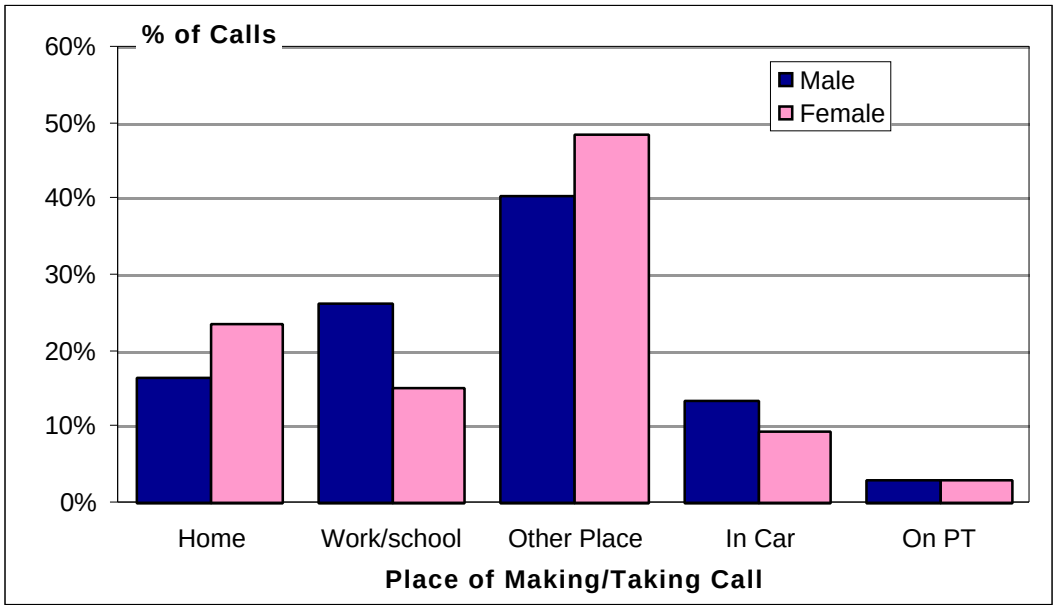

Figure 11 Place of Making or Taking a Call by Gender in Japan

The place where mobile phones are used, however, varies with the age of the user, as shown in Figure 12. Younger people are more likely to use a mobile phone at home (teenagers are probably using the mobile phone to avoid sitting on the main land-line phone when others are wanting to use it), while those in their twenties may only have a mobile home (even at home). Older people are more likely to use the mobile phone in public places, and also while in a car. Indeed, 15-18% of all mobile phone calls from people over 35 are made to or from a car. This has significant implications for the interaction between mobile phone use and travel and activity scheduling.

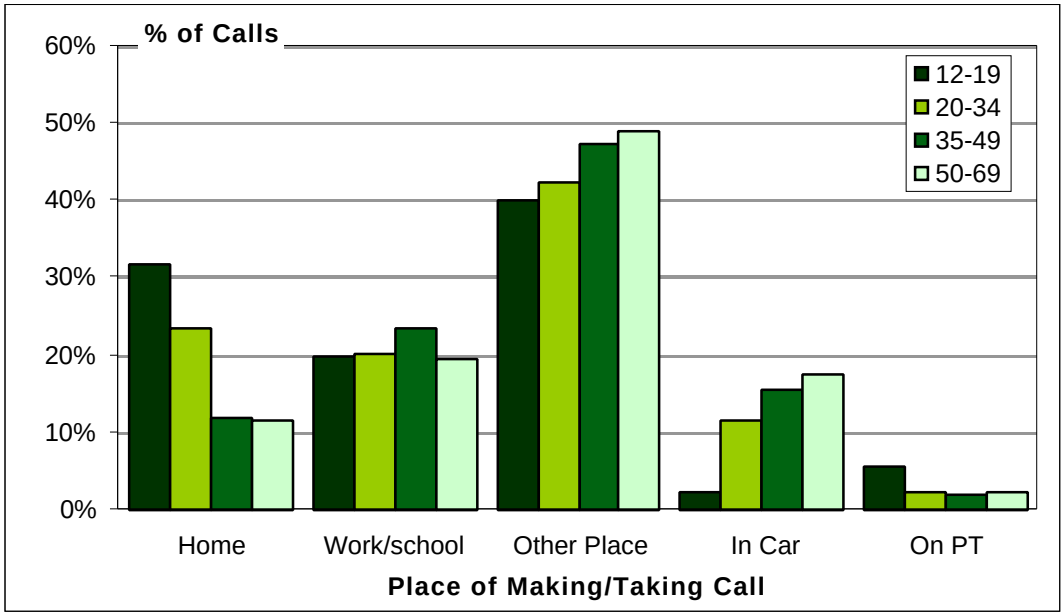

Figure 12 Place of Making or Taking a Call by Age in Japan

The interaction between mobile phones and travel can also be considered using the Australian data, by examining the trip situations in which mobile phones are more available. Figure 13 shows the proportion of trips, of various purposes, on which a mobile phone was available (in the car and switched on) for males and females. It can be seen that mobile phone availability is highest for trips to and from work and while driving for work purposes, and is lowest on shopping trips. For all trip purposes, except shopping, males are more likely to have a mobile phone available than females.

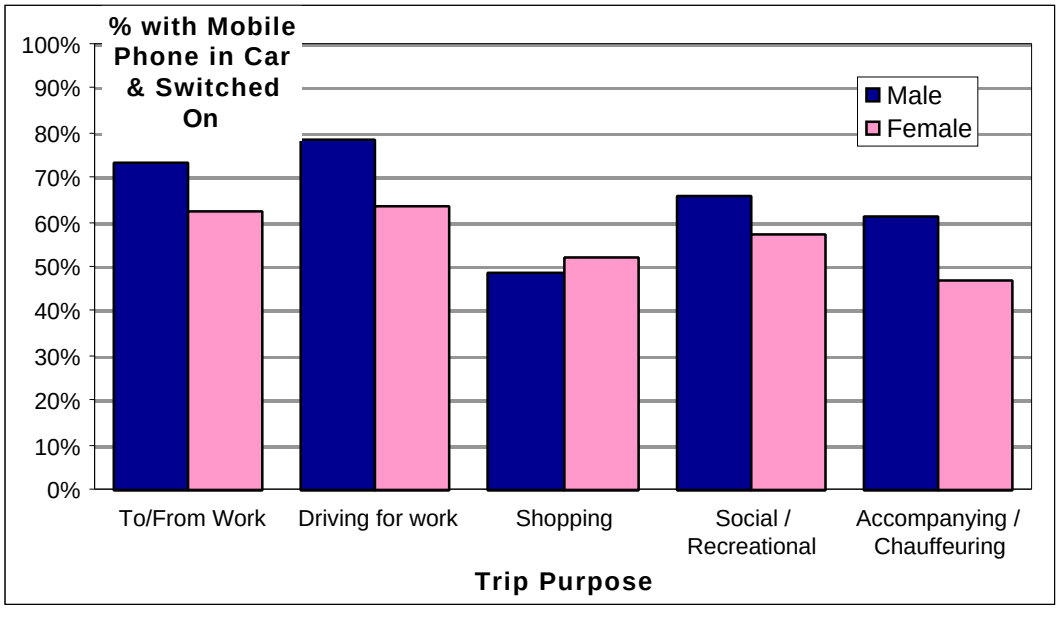

Figure 13 Mobile Phone Availability in Car by Trip Purpose in Australia

Mobile phone availability is shown as a function of the timing of the trip in Figure 14. It can be seen that, on weekdays, mobile phones are more likely to be available on trips in the morning and in the evenings, and less available for trips during the day. On weekends, however, there is little variation in mobile phone availability across the entire day.

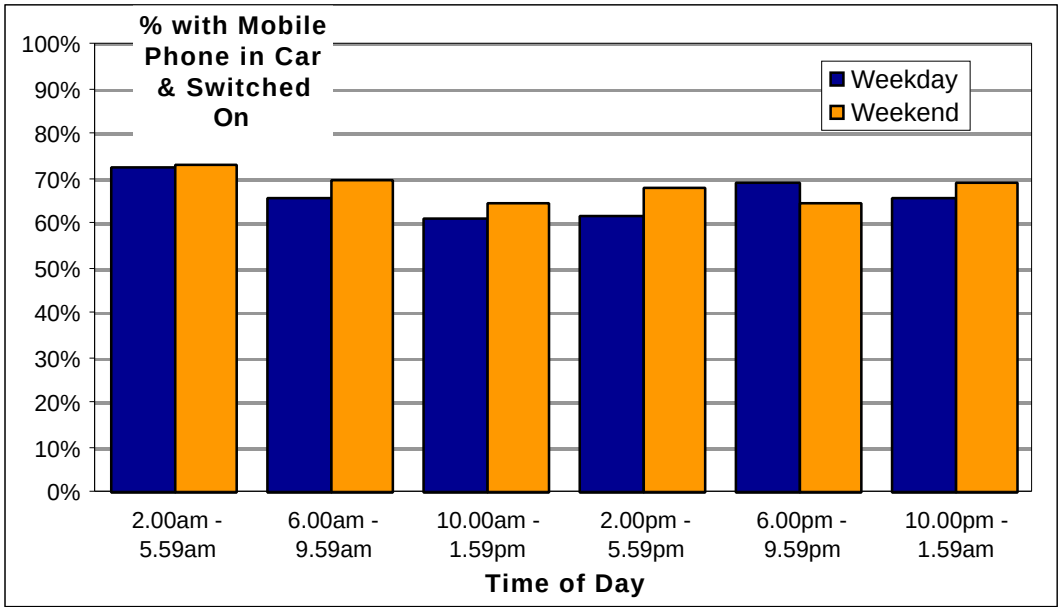

Figure 14 Mobile Phone Availability in Car by Time of Trip in Australia

4. Communications and Travel

The information of mobile phone use patterns and their possible relationship to travel and activity scheduling is mostly speculative. While there are plausible reasons for how mobile phones might influence travel patterns, there is no hard evidence. What is needed is a single data set which combines travel and mobile communications in the same framework. Unfortunately, there are very few examples. Mokhtarian and Salomon (2002) provide some examples of studies which have investigated the relationships between travel and telecommunications, but with one exception (Yim, 1994) the studies have concentrated on the use of conventional fixed phones. While Yim (1994) concluded that "cellular communication generated additional trips rather than substituting for them", Mokhtarian and Salomon (2002) cast doubt on this conclusion, citing problems with "attribution of causality" to the cell-phone. They raise the possibility that "it was not the cell phone per se but rather any phone that caused the trip".

Zumkeller (2001, 2002) has been one of the pioneers in examining, quantitatively, the relationships between telecommunication and transport, and in designing surveys which address both aspects of interaction. However, once again, mobile

communications do not receive special attention, with all types of phone calls being classified as a "phone call".

It was therefore with some excitement that, while working on data from the 1997 Australian Time Use Survey (ABS, 1999) for another purpose, we realise that the 1997TUS recorded phone calls as part of the time use survey, and also recorded the type of phone being used and the purpose of the phone call. It was therefore with some disappointment that we found after some analysis of the data that of the 6556 phone calls recorded in the data as primary or secondary activities, only 32 were made with a mobile phone and only 4% had a specific purpose recorded (the other 96% of calls were recorded as simply "talking on the phone").

Since time use surveys would appear to be a potentially fruitful data sources for looking at the relationships between mobile communications and travel, we therefore inquired in the Time Use Research community as to what data sources might be best suited for such analysis. Unfortunately, the situation was summed up most succinctly by Dr. Andy Harvey (Director, Time Use Research Program, St. Mary's University, Halifax, Canada)) when he stated that "Unfortunately I do not know of any. Technology has been essentially a wash in time use studies. Hopefully if we get our grant, we will focus on that in our survey".

It therefore appears that with current data sets, there is little possibility of quantitatively exploring the relationships between mobile communications and travel. However, rather than abandon all hope at this point, we decided to follow up on the suggestion of Mokhtarian and Salomon (2002) that "it was not the cell phone per se but rather any phone that caused the trip". That is, if we can't explore the relationships between mobile phone use and travel in the 1997TUS data, then let's see what can be gleaned from an examination of the relationships between phone communications (in general) and travel.

In exploring these relationships, there are a number of possible hypotheses that could be tested:

- Phone calls are a substitute for travel
- Phone calls stimulate travel
- Phone calls are used to plan travel
- Phone calls may disrupt planned travel

The following analyses attempt to cast some light on the validity, or otherwise, of these various hypotheses.

The average number of trips per person per day was 4.1, and the distribution is as shown in Figure 15. About 11% of people were immobile on their survey day. The distribution of trips from this time-use survey was very similar to that found in more conventional travel surveys.

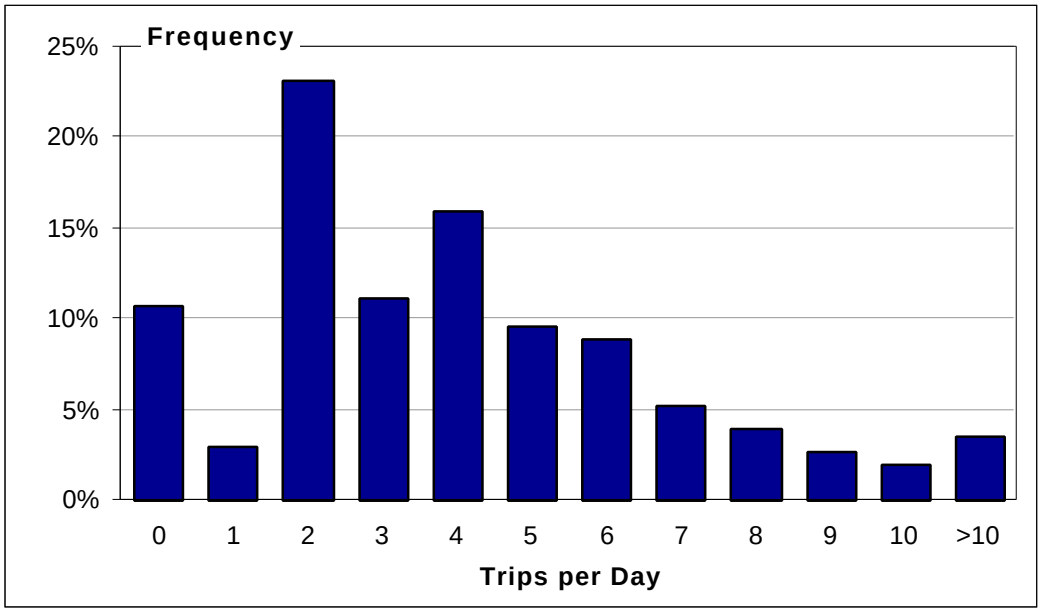

Figure 15 Frequency Distribution of Trips per Day

The average number of phone calls per person per day was 0.5, and the distribution is as shown in Figure 16. About 70% of people made no phone calls on their survey day.

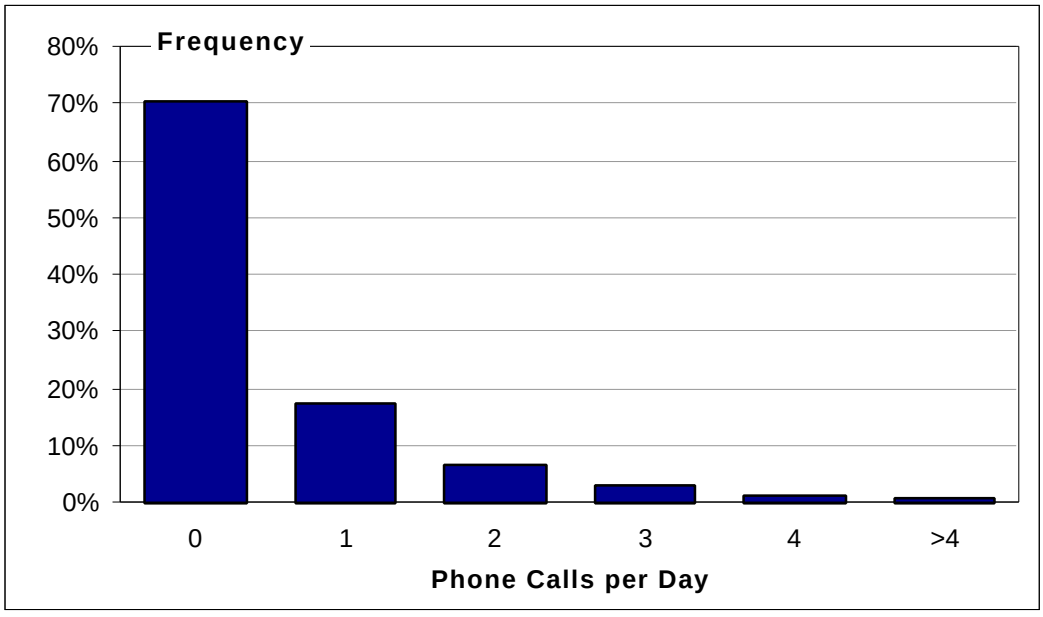

Figure 16 Frequency Distribution of Phone Calls per Day

One way of testing whether trips and phone calls are substitutes or complements is to examine whether those making more trips make more or less phone calls. As shown in Figure 17, it appears that trips and phone calls are complementary, since those making more trips also make more phone calls. This does not imply that the phone calls cause more trips, but merely that those making more trips also make more phone calls.

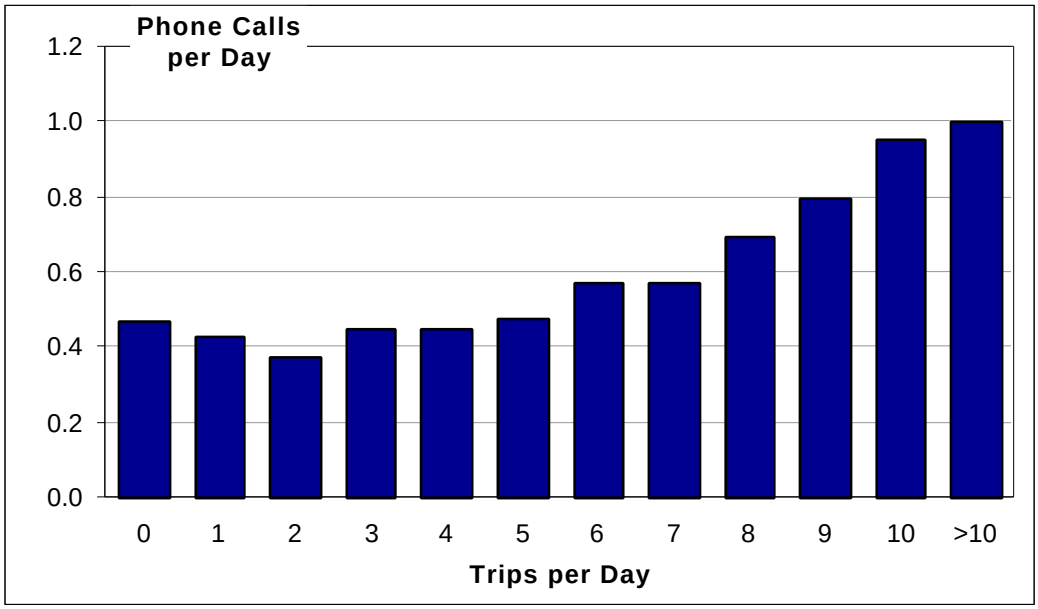

Figure 17 The Relationship between Trips per Day and Phone Calls per Day

The demographics of tripmakers and phone callers, in terms of age and gender, are shown in Figures 18 and 19.

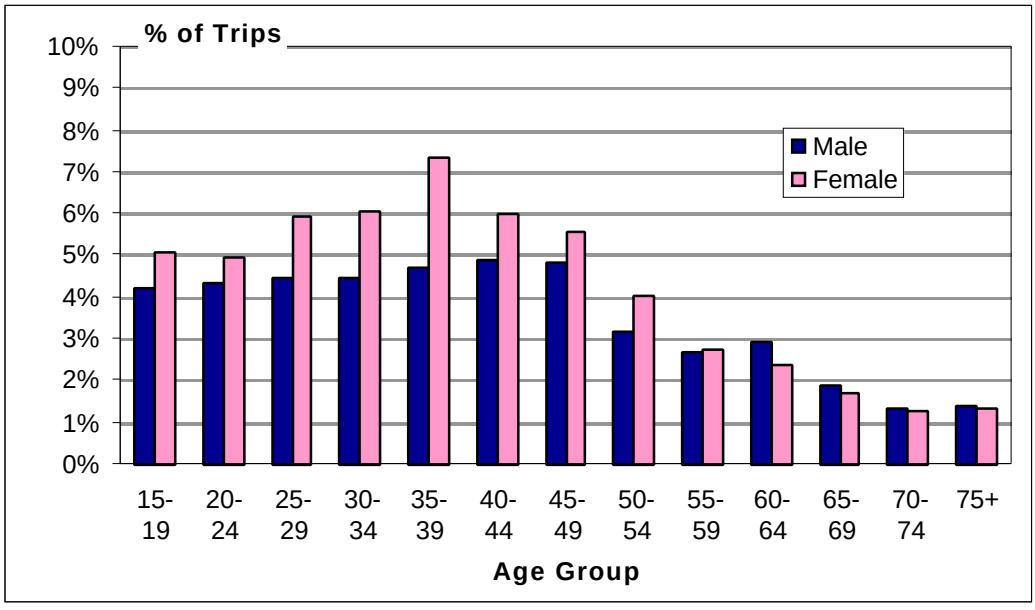

Figure 18 Percent of Trips by Age and Gender

The incidence of both trips and phone calls peaks for people in their late thirties. Interestingly, females make more trips and phone calls than males in nearly all age groups. This is especially the case for phone calls where females make about 75% of all phone calls.

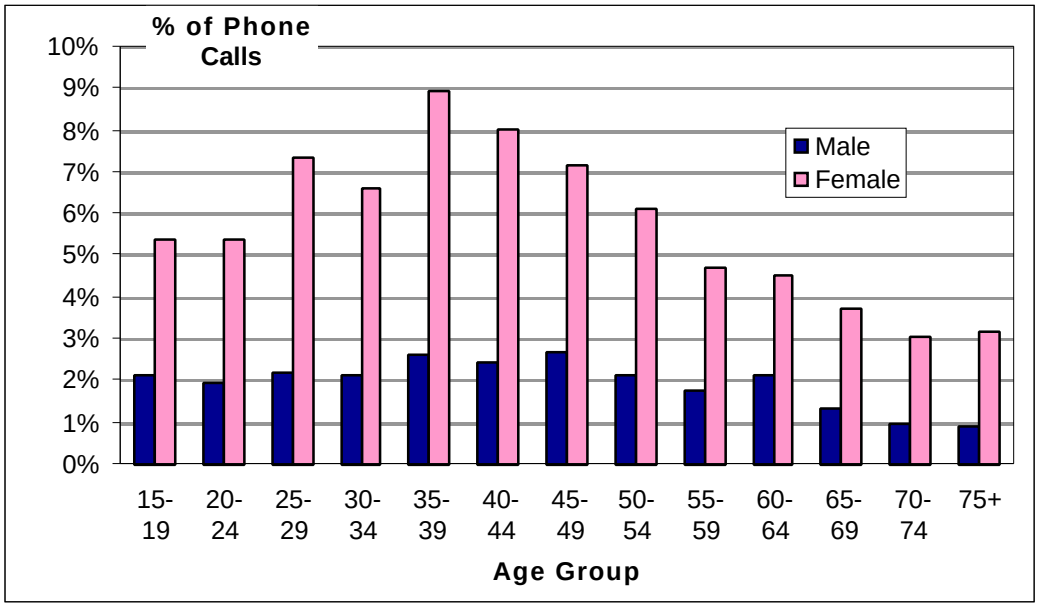

Figure 19 Percent of Phone Calls by Age and Gender

The distributions of trips and phone calls across the day are shown in Figure 20. The main feature of this graph is that trips are almost an order of magnitude greater in number than phone calls.

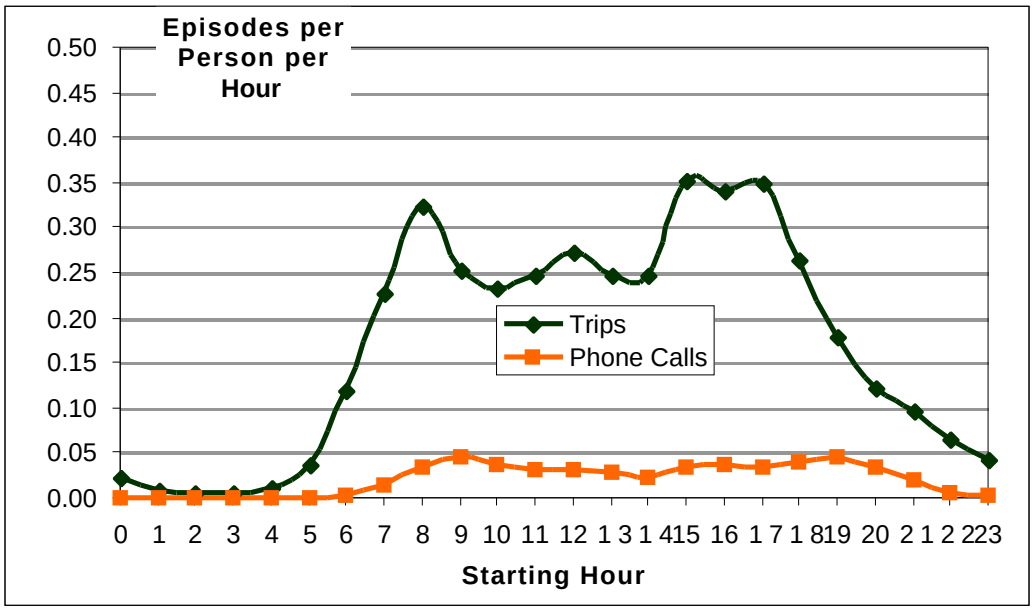

Figure 20 Trips and Phone Calls per Person per Hour

The shapes of the distributions are better appreciated by calculating the proportion (rather than the absolute number) of trips and phone calls per hour, as shown in Figure 21. It can be seen that both trips and phone calls go through two major peaks; one in the morning and one in the evening. However, it is clear that the phone calls lag the trips by an hour or two in both the morning and the evening.

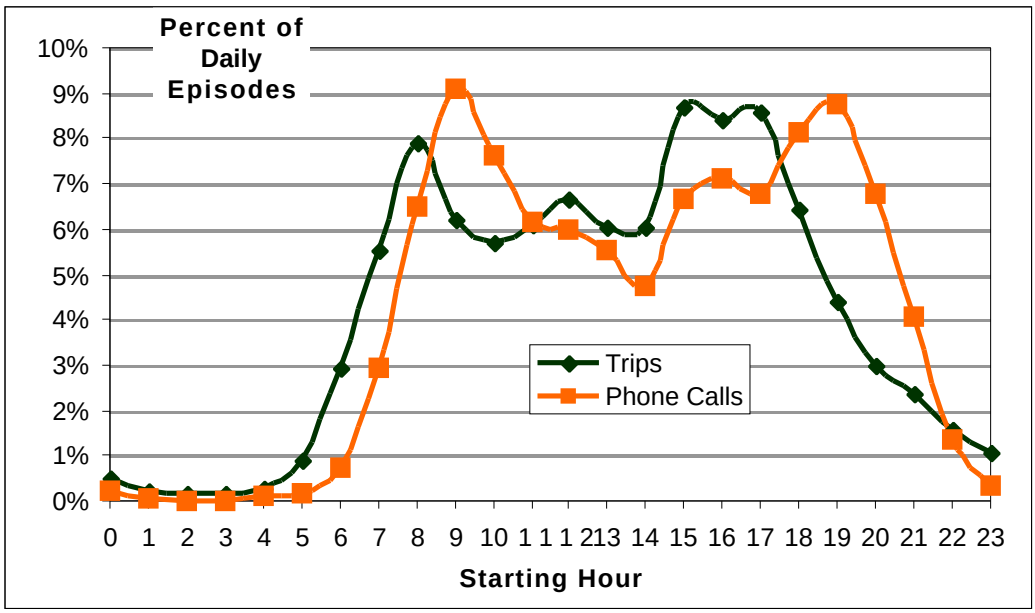

Figure 21 Percent of Trips and Phone Calls by Hour of Day

The average duration of trips and phone calls across the day are shown in Figure 22. It can be seen that during the day, trips and phone calls have about the same average duration of about 20 minutes. However, early in the day, trips are longer, and during the evening, phone calls are longer.

The distributions of trip and phone call durations are shown in Figure 23. It can be seen that phone calls are slightly longer overall. One important aspect of the time use data becomes evident from a consideration of the trip and phone call durations. There are nearly no trips or phone calls with durations less than 5 minutes. For trips, this probably means that short trips such as walking trips are under-estimated. For phone calls, however, the impact is probably greatest for mobile phone calls, which one could argue are more likely to be much shorter in duration than fixed phone calls. This could also explain why there are so few mobile phone calls in the total data set. Such a limitation must be addressed in future data collection efforts if mobile phone calls are to be effectively measured.

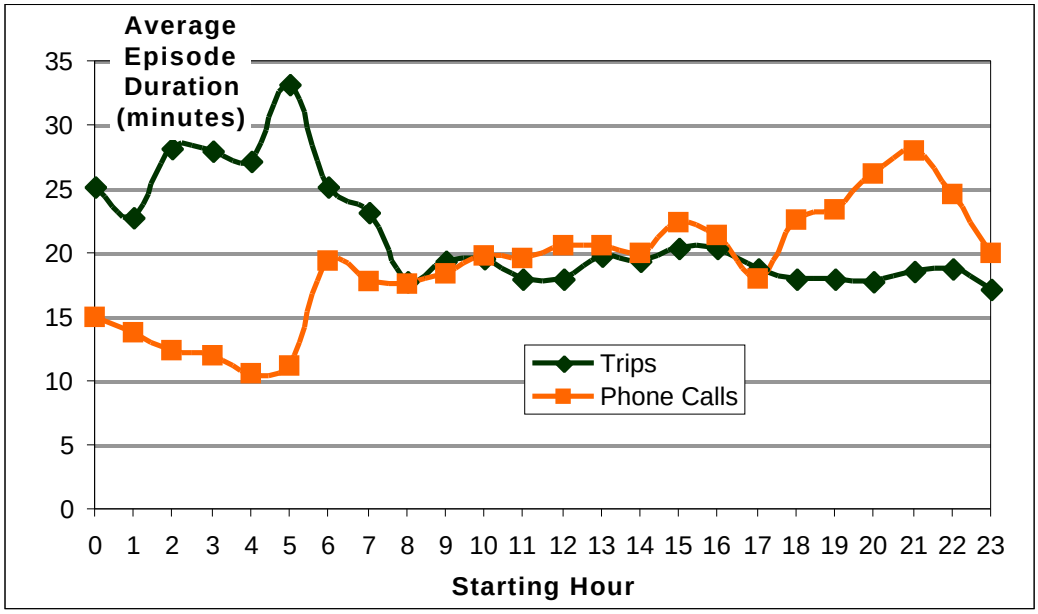

Figure 22 Average Duration of Trips and Phone Calls by Hour of Day

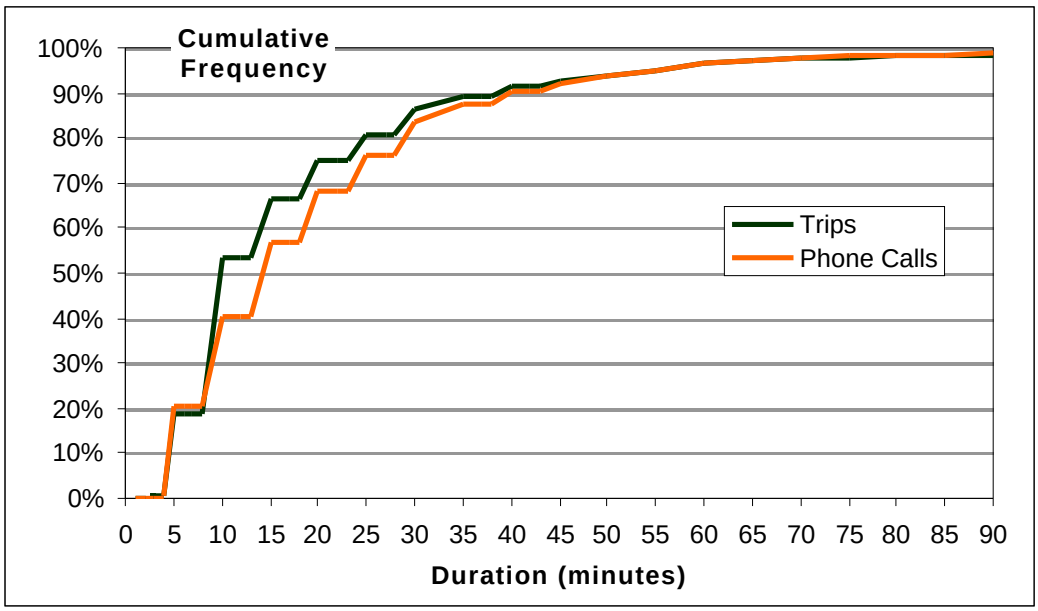

Figure 23 Cumulative Distributions of Duration of Trips and Phone Calls

The relative timing of trips and phone calls noted in Figure 21, whereby phone calls appeared to lag behind trips, is explored in more detail in Figures 24 through 29. Figures 24 and 25 show the temporal distributions of trips and phone calls for males and females under 30 years of age. Figures 26 and 27 show the temporal distributions of trips and phone calls for males and females between 30 and 60 years of age, while Figures 28 and 29 show the temporal distributions of trips and phone calls for males and females over 60 years of age.

It would appear that males and females under 60 all exhibit the same lag between trips and phone calls, with phone calls tending to be made after the morning travel peak (after arriving at work or after others have gone off to work and school) and after the evening travel peak (after arriving home at night).

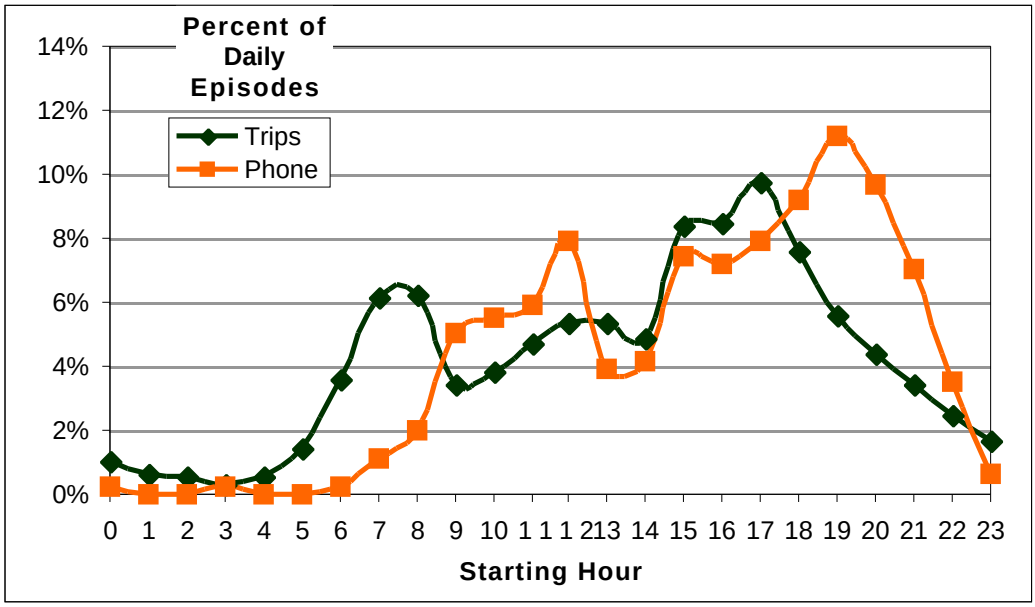

Figure 24 Trips and Phone Calls by Hour of Day by Males under 30

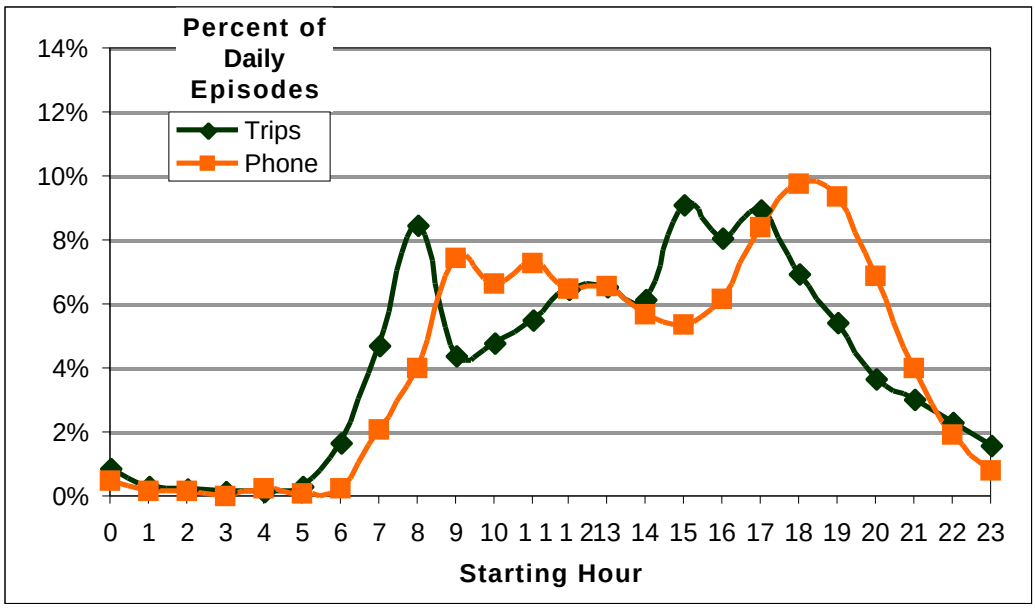

Figure 25 Trips and Phone Calls by Hour of Day by Females under 30

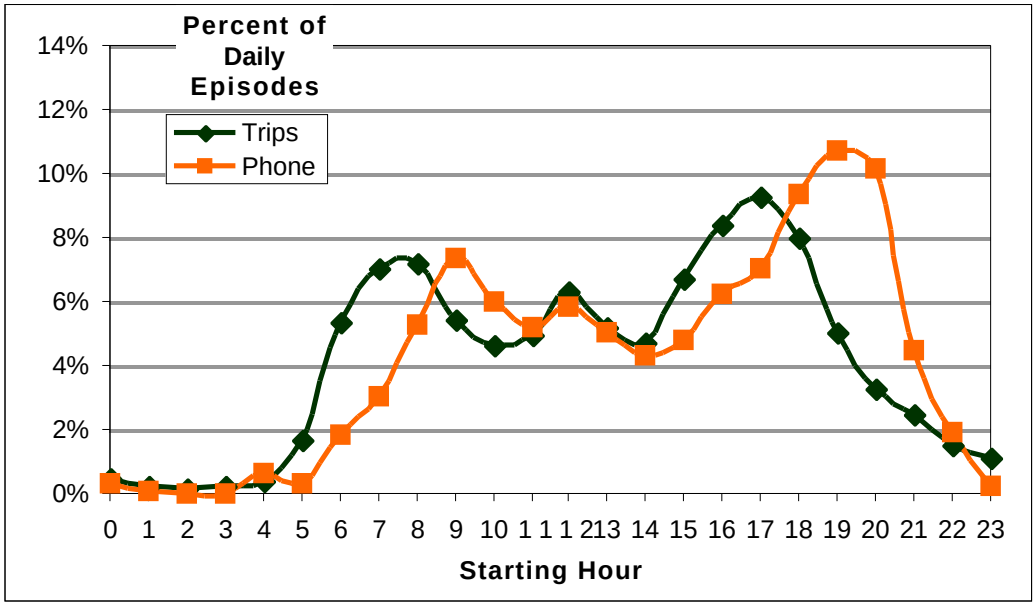

Figure 26 Trips and Phone Calls by Hour of Day by Males aged 30 to 60

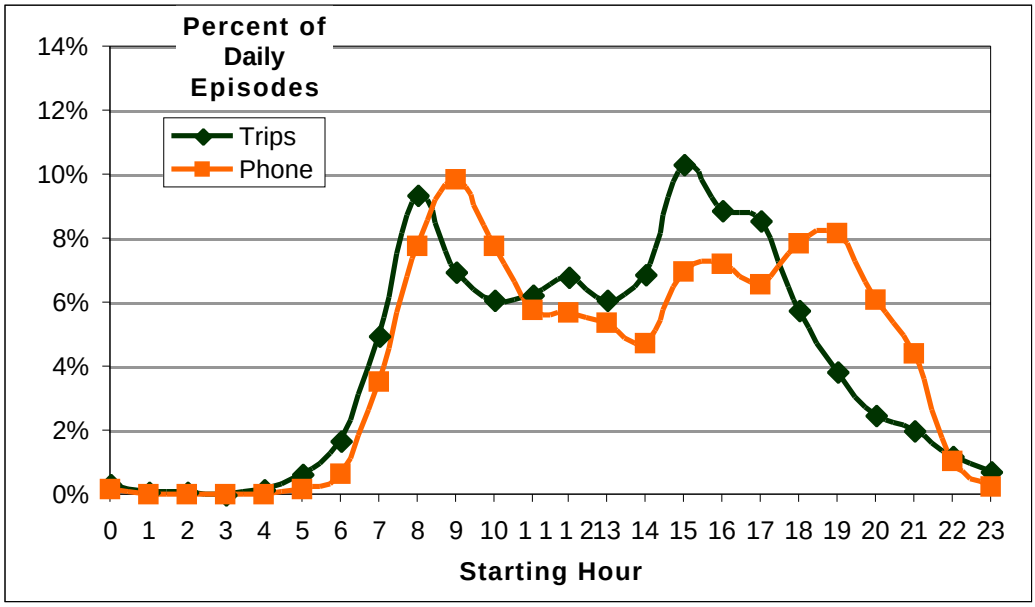

Figure 27 Trips and Phone Calls by Hour of Day by Females aged 30 to 60

On the other hand, males and females over 60 tend not to show a lag between trips and phone calls. People over 60 tend to have trip and phone call peaks in the morning, with both activities declining during the day. In the morning, the trip and phone call activity tends to rise together, suggesting a different relationship between trips and phone calls than demonstrated for those under 60. However, the reason for this difference remains uncertain, pending the collection of more detailed data about the relationships between the two activities.

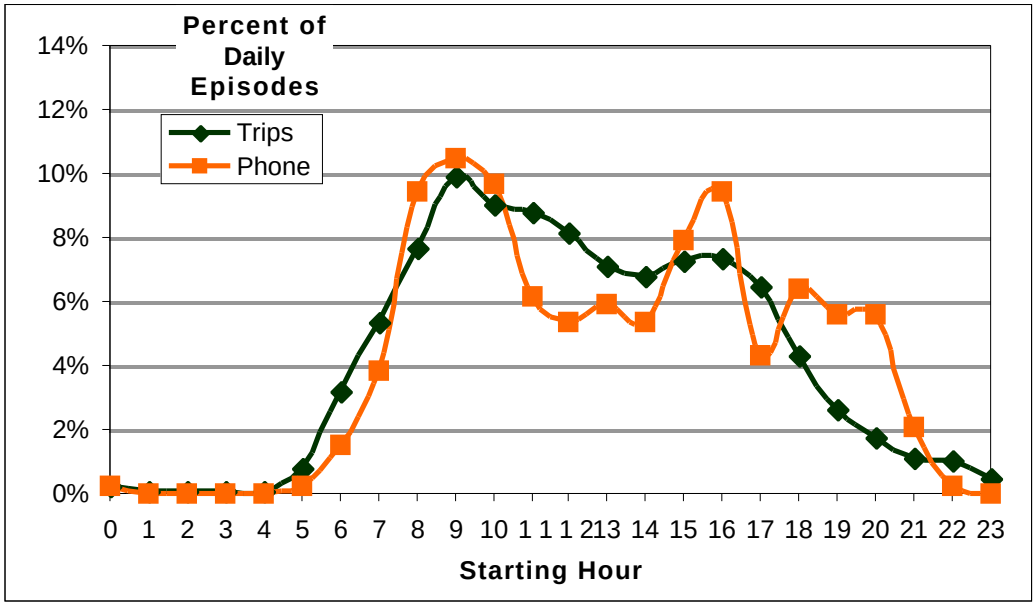

Figure 28 Trips and Phone Calls by Hour of Day by Males aged over 60

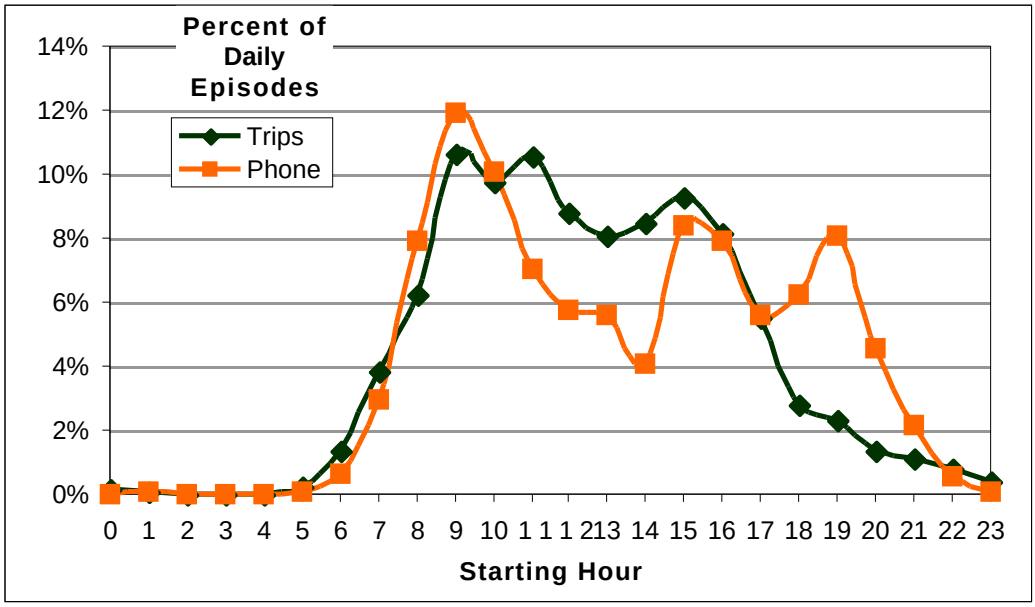

Figure 29 Trips and Phone Calls by Hour of Day by Females aged over 60

Unlike mobile phone calls, which take place mainly outside the home (Figure 11), fixed line phone calls take place mainly at home (as shown in Table 2). Also unlike mobile phone calls, the proportion of calls made at home increases with age.

Table 2 Place of Phone Call by Age and Gender

	Male			Female		
Place of Phone Call	Under 30	30->60	60+	Under 30	30->60	60+
Home	91.9%	89.2%	94.1%	92.2%	95.7%	99.0%
Workplace if outside home	2.4%	5.7%	0.5%	1.8%	1.6%	0.0%
Elsewhere	5.7%	5.1%	5.4%	6.0%	2.7%	1.0%

5. Data Issues for Mobile Communications

Even though the analysis of the 1997 Australian Time-Use Survey data did not shed much light on the use of mobile phones and their relationship with travel, it did highlight some issues that must be addressed in future surveys that wish to investigate the impact of mobile phones on travel and activity scheduling. The major issues are:

- If a time-use survey is used for data collection, the time interval used must be finer than 5 minutes. Many time-use surveys use recording intervals of 5 or 10 minutes, to ease respondent burden. While this may be satisfactory for other major activities, it is not useful for short duration activities (such as mobile phone calls) which can nonetheless have a profound effect of the rest of the time-use pattern. If a 5-minute recording interval is retained, then perhaps a separate method must be used for recording mobile phone calls.

- The presence of a mobile phone should be recorded during other activities, as well as whether it was switched on. This would measure the potential for activity scheduling to be changed via a mobile phone call.

- In order to understand the linkage between mobile phone calls and travel, the purpose of the mobile phone call must be recorded and the person on the other end of the line must also be recorded. This enables a direct link to be drawn between the phone call and any subsequent adjustments to travel patterns.

- A distinction must be made between calls made and call received (the so-called active and passive modes of communication (Zumkeller, 2002). This will enable identification of the triggering mechanism for any changes in travel patterns.

- Other mobile communications, such as SMS text messaging, should be recorded as well as audio phone calls.

Designing a data collection instrument with the above points in mind will greatly facilitate the investigation of the impact of mobile phones on travel and activity scheduling.

6. Conclusions

This paper started with the intention of examining the impact of mobile phones on travel and activity scheduling. The study was hampered firstly by a lack of accessible data on mobile phone ownership and general usage patterns, and secondly by a scarcity of any data sets which jointly record travel and the use of mobile phones. As a means of obtaining some insight into the design of future data sets which cover

travel and the use of mobile phones, an analysis was performed on the 1997 Australian Time-Use Survey data, concentrating on the use of fixed phones and their relationships to travel patterns. It was found that trip patterns and phone use patterns could be analysed in a similar fashion and that there were some consistent patterns to their usage in terms of timing and the demographics of users. Finally some recommendations were made for the design of future data sets which would truly enable a more detailed study of the impact of mobile phones on activity scheduling.

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