Understanding the Current Travel Patterns and Use of Technologies in Family Households

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Abstract

The purpose of the research is to understand the current travel attitudes and habits of families, and also to understand the current usage patterns of technologies in families. The study aimed to identify where opportunities exist for digital technologies to influence travel attitudes and habits in families. In order to conduct research into the role that technologies could have in this setting, the context of use needed to be fully understood. Therefore an exploratory approach was taken. A greater understanding of the daily travel patterns of family units and how they interact with technologies on a daily basis was achieved. The study used a mixed methods approach to capture and explore travel behaviours and use of technologies in 13 family households. A questionnaire was given to households to gather data on demographic variables of the family that might affect their travel behaviour. A diary study captured patterns in household travel and in how and when family members use technologies in their everyday lives. Interviews were carried out to increase understanding of their motivations and explanations for why they chose certain modes of transport and the reasons behind their uses of technology. The household types associated with high car usage were households with two or more cars and households with an older child (10+ years old) living in the house. The adults in households with an older child also took more single occupancy car trips. Several one car households, who travelled by active modes of transport regularly on working days/weekdays, took a higher proportion of weekend trips by car. A smartphone was the technology used most often before a journey. The conclusions of the study should help to guide the development of an intervention delivered using digital technologies that aims to influence the travel behaviour of family groups.

Keywords: Travel Behaviour, Technology Use, Households, Families

Introduction

People routinely choose to travel by unsustainable modes of transport, such as cars (Department for Transport 2013). These modes of transport are responsible for higher emissions of carbon dioxide than sustainable travel methods such as walking, cycling, lift sharing or public transport. These carbon dioxide emissions, produced in higher quantities by motorised transport, are contributing to the acceleration of global warming that is thought to be due to human activities (Chapman 2007). Individuals are each making small and seemingly insignificant decisions about which mode of transport to choose, however these decisions collectively are increasing the amount of carbon dioxide that is being released into the atmosphere (Chapman 2007). Decisions on personal travel behaviours determine the carbon footprint of an individual. If people switch to active forms of transport there are many other benefits for the people themselves and for the environment, for example people are able to maintain their current weight or lose weight more easily when they are more active (Jeffery et al. 2003). Initiatives could encourage people to change their travel behaviour so they are travelling by sustainable modes of transport more often/on a more regular basis.

Alongside an increase in carbon emissions from unsustainable modes of transport, there has been a rapid growth in the ownership and use of digital technologies which can be used for internet access; between 2006 and 2014 the number of adults in Great Britain who access the internet every day has increased from 17 million to 38 million. Access to the internet using a mobile phone (number who said they accessed the internet using a mobile phone in the previous 3 months) has increased from 24% in 2010 to 58% in 2014 (Office for National Statistics 2014). The proportion of UK adults who own and use a smartphone has risen to 66% (Ofcom 2015), and people are likely to carry a mobile phone and smartphone with them most of the time.

Research has looked at the potential for digital technologies to be part of the solution to reducing journeys made by unsustainable modes of transport. Previous research has indicated that opportunities exist for delivering successful behavioural interventions using digital technologies. Some of these studies involved the use of digital technologies to influence travel behaviour specifically (Froehlich et al. 2009). Some of these interventions have successfully influenced travel behaviour, for example in a study by Jariyasunant et al. (2013) where participants were provided with personalised data on their carbon footprint, times of journeys, exercise during active travel and costs of their transport. This feedback received by participants reduced the frequency of car trips. Another study to have successfully altered the travel behaviour of participants was the testing of the 'UbiGreen Transportation Display' prototype mobile app that was developed to give users feedback on their transportation habits (Froehlich et al. 2009). The prototype app used automatic trip detection and self-reporting of travel habits from users to track their transportation habits and activities and provided users with feedback of these activities on their mobile phone background home screen, to increase users' awareness of their travel habits. The app calculated how many journeys they took over a week by sustainable modes of transport. The majority of trips taken within the week by participants were 'green.' Walking was the most frequent method. Participants were positive about a 'growing tree' visual representation design when it was presented to them. The tree 'grew' in response to green transportation habits.

Previous studies such as these have shown the potential for digital technologies to influence the travel behaviour of people by providing the user of the technology with individual feedback on their behaviours e.g. (Froehlich et al. 2009), however in most of these studies the target of the behaviour change has been individual participants without links to each other. A small number of studies have used the social norms approach to travel behaviour change among a group of participants who do not know each other. The purpose of the social norms approach is to influence the behaviour of individuals by providing feedback on the behaviour of others. Users of the CHARM digital technology (Rettie et al. n.d.) were informed of what behaviour was 'normal' among the other users of the app, by presenting the user an average for distance walked along with feedback on their own walking. Providing users with group feedback alongside individual feedback increased their engagement with the app, and thus their engagement with feedback on their walking habits.

There is a gap in the research in that no research published so far has studied the influence of feedback from digital technologies on travel behaviour when the digital technology is used collectively by a social group where the individuals have links to each other, for example in a family unit or a group of friends. Social groups are made up of individuals interacting with each other, where there is a sense of unity within the group. The individuals in the social group have shared characteristics. Although no research published has studied the influence of digital technologies on travel behaviour in social groups, in the research area of health behaviour change in general some studies such as the Houston app study (Consolvo et al. 2006) had groups of participants known to each other all using a digital technology that encouraged a shift in behaviour change to encourage 'healthy' behaviours. In the Houston app study, the social groups in this study were groups of female friends. The app encouraged the user to be physically active by allowing them to share their daily step count with friends. By providing the user with this ability, the app can increase the users' personal awareness of their activity levels which could increase their levels of physical activity. The group of females who shared their step count with friends were significantly more likely to achieve their goals for amount of walking/activity.

Family groups are an interesting and promising social group to investigate because they are responsible for a large proportion of journeys made by unsustainable modes of transport that are contributing to increasing carbon emissions. A greater number of trips were made by people who are a member of a household with two adults living with children than in any other type of household in the year 2012 in the UK (Department for Transport 2013).

Within family groups, it will be the parents or guardians who will tend to decide on the travel choices and patterns of behaviour for the whole family. The activity choices of their children will also influence the travel choices. There are additional reasons why families may not choose to travel in a sustainable way, for example in the morning the parents may need to make several journeys to take children in the family to school and then to travel to their workplace. They may only have time to travel by private car in order to fit in all journeys into this limited amount of time. Chauffeuring of children has to fit around the work routine of the adults in the family. When there are two working parents in the household, the family is under an increased time pressure (Fyhri et al. 2011) compared to households with only one parent working full time. Some of the reasons why

walking and cycling may seem less appealing to families might also be that they are concerned for the safety of children walking or cycling to school by themselves. Public transport may seem less appealing if parents believe it will be expensive or will be too time-consuming, or if they do not trust their children to travel by public transport by themselves (Fyhri et al. 2011).

Households with younger children are under increased time pressure for various reasons; care of younger children puts constraints on the daily travel behaviour of the adults (Hannes et al. 2012), and young children especially are unable to use certain modes of transport by themselves. A shift from dependent to independent school travel occurs after the transition between primary to second school in many cases, which again places more time constraints on parents with primary school age children (Peetermans & Zwerts 2006). Teenagers may still need to be chauffeured to activities in the same way that primary school children often need to be. School and work routines, participation in activities, drop off and pick up arrangements etc constrain the travel routines of households, especially households with young children (Hannes et al. 2012).

A small number of studies have targeted family groups to influence travel behaviour. A gap in the research exists in terms of knowledge of how digital technologies might be used to target family groups to change the collective travel behaviour of the family. A longer term advantage of targeting family groups rather than individuals is that by targeting a parent(s), you're not only influencing the travel behaviour of that/those individuals, you are also influencing the behaviour of their children, so a greater number of individuals have been influenced than if you choose to target a single adult without children. In addition, children will one day be independent travellers themselves who make their own decision on travel behaviour. If they can be influenced at an earlier age then it is possible they may be more easily motivated to choose sustainable modes of transport.

The research gap exists around how digital technologies could be used to encourage social groups to change their travel behaviour so that they are travelling in a more sustainable way. In order to understand how it might be possible to alter the travel behaviour of social groups, in this case family groups, it is vital to recognise how families are currently travelling and using technologies, and which types of family groups have scope for behaviour change and which do not, either because this type of family is already travelling as sustainably as they can, or their circumstances do not allow travel behaviour change.

In addition, it should be noted that several studies such as Henne et al 2014, Fyhri et al. 2011 and Ridgewell et al 2009 have carried out research in a related subject because they study all the reasons why children travel to school by certain modes of transport, however households travel to a whole range of everyday travel destinations, covering all members of the household and various one-off and habitual journeys.

The studies mentioned in the previous paragraph have identified the key influencing factors on children's active travel. The factors positively associated with children's active travel include having parents who sometimes travel by active modes themselves, having a parent who is not licenced to drive and a child being older (Henne et al. 2014). Children who take part in more physical activity overall are more likely to travel by active modes to non-school destinations (Smith et al. 2012). The factors that increased the likelihood of a child being chauffeured by car and decreased the likelihood of them walking or cycling were having protective parents who worried about personal safety and traffic, longer working hours for the parents (Henne et al. 2014), easier access to cars for the parents, parents being 'on-call' via mobile phone to arrange collecting their children, increased time pressures, perceived convenience of car use, increased distance to school (Fyhri et al. 2011) and both parents being employed on a full-time basis (Hannes et al. 2012).

This research aims to identify the types of journeys where families are frequently travelling by unsustainable modes. For some of these journeys, it may be possible for behavioural change to take place, for example if the destination is close enough for that person to walk or cycle to.

The theory underpinning the behaviour change of peoples travel behaviour to encourage them to switch to active modes of transport is Prochaska and Di Clemente's Transtheoretical Model of Health Behaviour Change, also known as the Stages of Change model (Savage et al. 2011). It describes intentional behaviour change.

The stages of the model are:

1. Pre-contemplation – no intention to change
2. Contemplation – intend to take action within next 6 months, but not ready (chronic contemplation sometimes occurs)
3. Preparation - intend to take action within the next month, aware of costs of benefits of change, may have plan of action.
4. Action – have made or are making specific overt behavioural changes, usually within the last 6 months
5. Maintenance – actively working to avoid a relapse in the undesired behaviour, usually having made the change more than 6 months ago
6. Termination – the new behaviour is now so ingrained it is now the norm, and relapse is highly unlikely
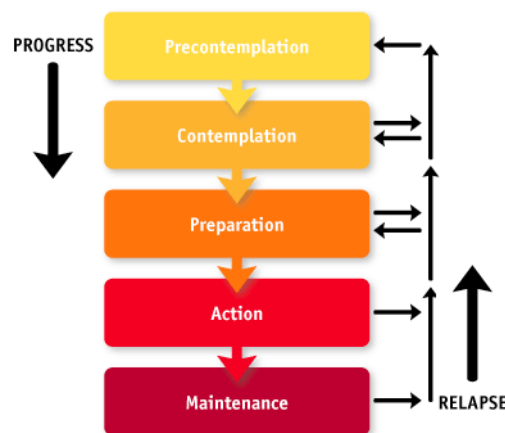

Figure 1 - Stages of Change Model (Addiction Info, 2010)

Although the Stages of Change model was originally developed to be applied to the context of health behaviour change, it has been successfully used in the context of travel behaviour change. Gatersleben and Appleton examined the attitudes of consumers towards cycling who were in different stages of change (Gatersleben & Appleton 2007). They concluded that different interventions are required to encourage people in different stages of the model to make the transitions towards action and maintenance. When trying to understand the travel behaviour of family households it would be useful to consider which stage of the Stages of Change model the household is in in terms of their daily travel behaviour. When considering the Stages of Change model, the focus will be on moving people from car use to use of active modes of transport.

Methodology

This section describes a mixed methods study involving 13 households. The study used a mixed methods approach to capture and explore both travel behaviours and the use of digital technologies in families. Specifically, it comprised of three elements, namely: a questionnaire to gather demographic variables of the households, a travel and technology use diary and in-depth interviews. The reason for including the three levels of data capture in the study, the questionnaire, the diary study and the interview, was to capture data on journeys and technology use in situ and then to ask participants to reflect back on the journeys they had made in the interview. To test if the diary instructions were easy to understand, a pilot study was conducted. Another purpose of the pilot study was to test if the participants filled out the diary correctly with the desired information. The pilot study also included a run through of the demographics questionnaire and the interview process to check if the proposed methods were feasible.

Stage of Data Collection	Method	Purpose
Recruitment	Recruitment emails sent	Recruit 13 households
Study Briefing	Face-to-face meeting to talk through the 3 stages of the study. Blank copy of diary given to participants	Explain what is required and engage participant to increase participant retention
Questionnaire	Participant fills in Demographics Questionnaire at Study Briefing. Days the participant will fill in the diary are chosen	Gather data on demographic variables
Diary	Participant fills in diary of their travel and technology use over a four day period	Capture patterns in household travel and technology use
Diary returned to researcher	Researcher collected diary from the participant	Diary collected so interview questions could be finalised
Diary studied to finalise interview questions	Travel and technology use studied so interview questions could be finalised	To ask interview questions about specific instances of travel and technology use
Interview	Questions asked on reasons for mode choice and uses of technology shown in diary, technology use in general	Increase understanding of motivations behind travel decisions and technology use

Table 1 - Stages of Data Collection

The requirements for taking part in the study were that households should live in Loughborough, a town of 60,000 people in central England, or the surrounding area and that they should include at least one child of primary school age and at least one working parent living in the household. This was to ensure that all families had access to similar public transport provision. The requirement that each household needed to include at least one child of primary school age was put in place because it tends to be children of primary school age who are most dependant on their parents for travel (Baines & Blatchford 2012). Secondary school age children are often allowed to travel independently, so the cut off was put in place so that at least one children in the family was dependant on their parents to accompany them on all journeys. Children being dependant on the adults for travel is one reason why families are a unique group to study. The requirement that there should be at least one working parent living in the household was so that similar families would be compared; a family without a working parent may have less time pressure on them to drop children off at school and be at work for a certain time too.

Demographics Questionnaire:

A questionnaire was given to the households to gather data on the demographic variables of the family that might affect their travel behaviour, for example the number of children living in the household and the number of cars in the household.

Demographic variables of families that might affect their travel behaviour include the following variables; a two-parent or a single parent family, grandparents who live nearby who assist with transport/looking after children, if children are looked after by two parents who live separately, if children attend before or after school clubs, the number of cars in the family, age of the children, if both parents can drive and whether both parents work full time/part-time.

In brief the demographics questionnaire included information on employment or education status of members of the household, ages of family members, number of cars owned, days of the week the adults work (to decide which days the diary should be filled out), modes of transport used in a typical week and digital technologies used in a typical week.

It is important to know the ages of the children as younger children will be completely dependent on adults to travel with them to places, and if children are below school age then this will affect the travel behaviour of the adults in the household as it is one less child to take to school. An adult's travel behaviour will depend heavily on their employment status; if both adults work full time then they may be less able to take children to activities, and children may have to stay at before/after school clubs. The presence of an adult in the household who spends their time as a homemaker will alleviate some of the time pressures of dropping off/collecting children from school and ensuring they arrive/leave work at the required time. The number of cars owned by the household has an influence on the number of times car trips are taken (Van Acker & Witlox 2010); households with more than one car take more car trips. Within a household with only one car, or no cars, member of the family may have to make journeys by sustainable modes of transport if another member of the family is already using the car.

Travel Diary:

The households each filled out a travel diary over a four day period that captured details of all the journeys made by members of the household. This four day period included two weekdays and two weekend days, but these days did not have to be consecutive days. The households were told to fill in the diary on days their travel would be typical. They also filled in a technology use diary that captured details of all the interactions members had with technologies over this same four day period. Data collection for the study took place between Dec 2014 and March 2015.

The Travel Diary captured details about each journey, which included start and end points, journey start and end time, length of the journey in miles or km (whichever they were more comfortable reporting), mode(s) of transport used, who in the family was involved in the journey and where anyone not part of the family was involved in the journey.

Another key component of the travel diary was that for each journey in the diary, participants had to fill in a box asking if any technologies were used 15 minutes before the journey, during the journey, or 15 minutes after the journey, and what these technologies were used for.

Technology Use Diary:

The Technology Use Diary consisted of a tick list of all the potential digital technologies that could be used by the members of the household on a typical day. For each of the four days, the participant was asked to tick the boxes to indicate each type of digital technology that has been used on that day, covering all technologies that have been used by members of the household. For each digital technology they had ticked, they were asked to write a very short description on what this technology had been used for.

Semi-structured Interviews:

The purpose of the interviews was to understand the decision making behind the travel behaviours shown in the diary, to ask about how people felt about their technology use and to gauge what participants thought of travel behaviour change initiatives they were aware of. The main contact from each of the households, who had been in charge of filling in the travel diary and had met face to face with the researcher, was interviewed. The other members of the household were not interviewed.

Participants were asked about the main factors influencing their decision to travel by a certain mode of transport for a journey recorded in the diary. The interviewer sought out the reasons behind technology use in relation to particular journeys. Participants were also questioned on a specific instance where they had used a particular technology to plan a journey in the diary, and asked general questions on how they used technologies to plan journeys.

The researcher wanted to know about technology use to plan both habitual and one-off journeys. Participants were asked if they had ever used technologies to plan a habitual journey when they first started to make this journey on a regular basis. They were also asked to give an example of when they had used technologies to plan a one-off journey.

Data Analysis:

All results from the travel diary were entered into an excel table for numerical analysis. Means for each variable, such as mean distance of a car journey, could be calculated for each family, and then for all households overall. For each individual trip recorded in the diaries, all relevant data around the trip was recorded, which included journey purpose, if it was a weekend or weekday journey, habitual or one-off journey, time of day, length of the journey in minutes and miles, adults and children involved in the journey, mode of transport used and technologies used around the time of the journey (if any). All this information was coded as a single row in the excel data table.

Shared characteristics, demographically and behaviour wise, were noticed between households. The researcher then established which of the 13 households shared that characteristic and grouped them together for this exercise. For each grouping, the summary tables were checked for similarities in the patterns in the results. Interview transcripts were analysed using theme based content analysis. The content analysis technique used was quasi-statistical; conclusions were bases on word and phrase frequencies and inter-correlations between the codes (Robson 2002).

Results and Discussion

Travel Habits:

N = 358 for total number of journeys. Number of journeys on weekend days N = 138. Number of journeys on weekdays N = 220. The number of destinations is 397, which is greater than the number of journeys (358). This is because some journeys involved more than one destination, for example if there were stopping points on the way, which is referred to as trip-chaining.

Destination Category	Frequency
Home	162
Education	65
Recreational	60
Work related	57
Shopping	38
Family Visit	12
Pick up someone not in the immediate family	3

Table 2 - Frequency of Destinations

Overview of Journeys of Different Lengths by Different Modes for each Household:

| | Length of journey in miles | Journeys <1 mile | | | Journeys >1 mile and ≤2 miles | | | Journeys >2 miles | | |
	Mode of Transport Used	Car	Walk	Cycle	Car	Walk	Cycle	Car	Walk	Cycle
H1	Frequency	3	7	0	7	1	0	5	0	0
H2	Frequency	14	1	0	10	1	0	9	0	0
H3	Frequency	0	9	0	5	2	0	6	0	0
H4	Frequency	4	7	0	2	0	0	13	0	0
H5	Frequency	5	0	0	0	0	0	19	0	0
H6	Frequency	2	4	0	0	0	0	16	0	0
H7	Frequency	0	11	4	0	0	2	0	0	0
H8	Frequency	8	4	2	6	0	0	8	0	0
H9	Frequency	11	5	0	1	0	0	11	0	0
H10	Frequency	0	7	0	3	0	0	25	0	0
H11	Frequency	2	2	0	2	0	0	20	0	0
H12	Frequency	6	3	11	4	0	0	4	0	1
H13	Frequency	10	0	0	2	0	0	18	0	0

Table 3 - Overview of Journeys

The above table highlights the different modes that the households have used for various lengths of journeys. The colour coding represents the proportion of short journeys (defined as less than one mile) each household has travelled by car. Households that did not travel by car for any short journeys are highlighted in green, households than travelled by active modes for more than 50% of short journeys are in amber and households that travelled by car for the majority of short journeys are in red. Two households were balanced evenly between car use and active modes for short journeys and so were not highlighted by a colour.

A common explanation given for why these households chose to travel by car for short journeys were that they were under time constraints and thus there was not enough time to travel by another mode. One type of common short journey taken by car is to transport or collect children from school on the way to work or on the way back. Although in several instances the school is close to home and walking would be possible, several participants mentioned that either they needed their car for work so they needed to drive to school on the way to work, or there was not enough time to walk to school and then walk to work so driving was the only option.

The most common reasons participants gave for walking a short habitual journey were for the health benefits and because the destination was close enough to walk to. For several participants they prioritised walking their children to school as they considered this exercise to be very important, however they tended to drive for most other journeys.

Household Demographics - Grouping Households with Similar Characteristics:

Most of the groups that households have been assigned to originated from the demographic variables asked for in the questionnaire. These include number of children in the household and number of cars for example.

Households with one car only

Car usage in minutes per day on average tended to be lower in these households. Car usage in minutes per day on average for journeys involving children tended to be higher than average. Considering active transport, households with one car are walking more frequently and for longer. All these families mentioned the benefits of sustainable travel, e.g. money saving and health benefits in their interview. Some of the one car households who travel by sustainable forms of transport on the weekdays tend to travel mostly by car at the weekend.

Household Demographics Summary Table – Ranked by Number of Cars Owned by the Household and then Number of adults in the household who work full time:

HH No.	No. of Cars	No. of adults in HH who work full time	No. of children	Do they live close enough to school to walk or cycle? (<1 mile)	Do they report using active modes of transport at least once in a typical week?	Does at least one adult in the household NOT hold a Full Driving Licence?	Stage of Travel Behaviour
4	3	1	1	Y	Y	N	Action phase
6	2	2	2	Y	Y	N	Preparation/ Action phase
10	2	2	2	Y	Y	N	Action phase
2	2	1	2	Y	Y	N	Contemplation phase
5	2	1	3	N	Y	N	Contemplation phase
11	2	1	2	Y	Y	N	Contemplation phase
13	2	1	2	Y	N	N	Preparation phase
12	1	2	2	Y	N	N	Action phase
1	1	1	2	Y	Y	N	Action phase
3	1	1	2	Y	Y	Y	Action phase (for everyone except the father)
8	1	1	2	Y	Y	N	Action phase
9	1	1	3	Y	Y	N	Action phase
7	0	1	1	Y	Y	Y	Action phase

Table 4 – Household Demographics Summary Table

Households with two or more cars

For all seven households with two or more cars, total car use for the four days was around the average or higher than average. The three households, out of the total of 13 overall, with the highest totals for car use over the four days were all households with two or more cars. In terms of active travel, these 2+ car households had much lower than average total walking time for accounting for all family members added together. None of the households with two cars cycled.

Households where both parents are in full time employment

All three households with both parents in full time employment usually travel to school by active modes, and all see this as important. Whilst they all choose to travel to school by active modes, they are more likely to travel to work by car. For two of the three households, the only journey they made by any mode other than a car is the school run. The proportion of car journey time that involves at least one child was higher than average in these families. The number of car trips under two miles is below average for these households; they took a higher proportion of trips under two miles by active modes compared to the average.

Households with an older child

When considering the car use within this group, all three of these households showed a slightly lower than average mean length of a car journey in miles. Whilst the households with an older child or older children tended to drive more, the percentage of total car use that involved at least one child was below average for two of these households. Journeys under two miles were taken by car frequently. All three households with an older child travelled by active modes of transport for less than a third of journeys that were under two miles. Time pressure was given as the main reason they travel by car. Taking children to activities was very common within this group, possibly because older children are involved in more activities.

The tables on the following page are summaries of technologies used by households around the time of a journey.

HH No.	Desktop Pc	Laptop Computer	iPad/Tablet	Smartphone	Non-smartphone mobile phone	iPod/mp3 player	Digital Camera	In-car radio	Other type of radio	Television	DVD player	Games Console	Satnav	Kindle
1	0	0	2	19	0	2	0	7	0	8	0	0	0	0
2	0	3	0	5	0	0	0	17	0	0	0	0	0	0
3	2	0	0	3	0	0	0	0	0	1	0	0	0	0
4	3	0	0	20	0	1	0	9	0	6	0	0	5	2
5	1	0	0	9	0	0	0	16	0	0	0	0	0	0
6	0	12	0	2	0	0	0	18	0	7	0	0	0	0
7	0	8	7	20	0	0	0	0	0	9	0	0	0	0
8	1	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	3	5	1	2	0	14	0	0	0	0	0	0
10	1	5	1	13	0	1	0	14	0	2	0	0	0	0
11	2	5	0	10	3	0	0	20	0	0	0	0	0	0
12	0	0	0	1	0	0	0	4	0	0	0	0	0	0
13	3	2	6	26	0	1	0	29	0	14	0	2	0	0
Total	13	35	19	133	4	7	0	148	0	47	0	2	5	2

Table 5 - Combined Frequency Count of Technologies Used 'Before, During or After' a Journey, for each Household in Total

HH No.	Desktop Pc			Laptop Computer			iPad/Tablet			Smartphone			Non-smartphone mobile phone		
	Before	During	After	Before	During	After	Before	During	After	Before	During	After	Before	During	After
1	0	0	0	0	0	0	0	0	2	10	2	7	0	0	0
2	0	0	0	3	0	0	0	0	0	0	5	0	0	0	0
3	2	0	0	1	0	0	0	0	0	0	3	0	0	0	0
4	1	0	2	0	0	0	0	0	0	9	0	11	0	0	0
5	1	0	0	0	0	0	0	0	0	4	4	1	0	0	0
6	0	0	0	5	2	5	0	0	0	1	0	1	0	0	0
7	0	0	0	4	0	4	3	0	4	8	3	9	0	0	0
8	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	1	0	2	4	1	0	0	0	1
10	1	0	0	1	0	4	0	0	1	4	3	6	0	0	0
11	2	0	0	2	0	3	0	0	0	4	2	4	2	0	1
12	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
13	1	1	1	0	1	1	3	0	3	14	4	8	0	0	0
total	9	1	3	16	3	17	10	0	12	59	27	47	2	0	2

Table 6 - Frequency Counts of Technologies used around the time of a Journey broken down into 'Before,' 'During' and 'After' a Journey, for each Household, for the Technologies that could be used for Behaviour Monitoring/Change

Technology Use:

To highlight which technologies are used most often around the time of a journey in Table 6, from the group of technologies that could potentially be used to monitor or influence behaviour, technologies that have been used more than two times by a household either before, during or after a journey, have been shaded in grey. Technologies used more than 12 times in total across all households either before, during or after a journey have also been shaded in grey. The results in this table indicate that the technologies used most frequently around the time of a journey are laptops and smartphones. Tablet and desktops are also used relatively frequently around the time of a journey.

When considering the most frequent specific purposes of technology use around the time of a journey, listening to music on an in-car radio occurred most frequently, and the second most common use was text messaging after a journey, which occurred after 26 journeys. After 21 journeys a person watched television afterwards, and after 17 journeys text messaging (sending or reading a received text) occurred. When considering only technologies used before a journey, which could inform an intervention targeted at a participant just before they make a journey, the smartphone was the technology used most often before a journey. The most common tasks performed using a smartphone before a journey were text messaging, emailing, making phone calls, checking the time and navigating.

Google Maps was frequently mentioned by participants as a technology they use to plan journeys.

Interventions:

When considering potential interventions, for households under time pressure a potential intervention would be to give them information on actual time taken for each mode of transport for an example journey, as it may take less time than they think to travel by active modes.

Comparisons:

When comparing the results of this study to the conclusions of the studies in the introduction to this paper, Smith et al. 2012 found that children who travel to school by active modes are also more likely to travel to non-school destinations by active modes. This wasn't true in all cases for this study, as some households walked to school with their children yet travelled by car for almost all other journeys. Henne et al. 2014 found that having a parent who was not licensed to drive increased active travel in their children, and the same result was found in this study. In the two families where either one or both parents do not drive, the children of the family travelled by active modes the majority of the time. Henne et al.2014 also found that older aged children are more likely to travel by active modes. Teenaged children in the study were more likely to travel independently, and sometimes walk to school on their own.

In this study all three households where both adults were in full time employment usually always travel to school by active modes, and they see this as important. This is the opposite of the result of the study by Hannes et al. 2011 that found that households where both parents were in full time employment were more likely to drop their children off to school by car. Again within households where both parents work full time, Fyhri et al. 2011 found that time pressures on the family were increased, however the households in this study did not appear to be under increased time pressures as they were able to travel to school/work by active modes at least some of the time.

The most common reasons given in the interview for driving to school or work rather than using other modes of transport included time pressures, destination being too far away to walk, weather conditions, having bags to carry and there being no direct bus route. In comparison, the most common reason given by parents as to why their children didn't walk or cycle to school in the study by Ridgewell et al. 2009 was that adults didn't think it was safe for their children to walk to school because of fear of strangers and traffic danger. No participants in this study mentioned safety concerns as a reason for driving their children to school.

It would be preferable to deliver a travel behaviour intervention via a technology that is already being used by a participant around the time of a journey, so if they need to use this technology to enter information or receive feedback it would be less disruptive to their lifestyle as they are already using it. When looking at the technologies used most frequently around the time of a journey, the most common ones used were in-car radios, smartphones, televisions, laptops and tablets. When considering which of these technologies could be used to deliver a travel behaviour intervention, it would not be possible to deliver an intervention using a radio or television as the researcher cannot control this medium. Therefore these technologies can be discounted as potential ways to deliver

an intervention. The remaining commonly used technologies are smartphones, laptops and tablets. Of these three, it is smartphones that were used considerably more often around the time of a journey.

Conclusions

A travel behaviour change intervention could target households with two or more cars to encourage them to travel by active modes of transport more often in general, especially if they live close enough to work or school to travel by active modes. Households with an older child in this study appeared to travel by car more often and were more likely to take car trips with only one adult present. An intervention encouraging active travel could be more effective if delivered during the summer months. An intervention should definitely promote the health benefits of active travel, especially for children. An intervention delivered using a smartphone that also has a link to Google maps could be effective, and could fit more easily into people's lifestyles as they already seem to use Google maps before making a journey.

Households with one car are travelling more sustainably in general. Car usage in minutes per day tended to be lower than average, while the proportion of car journeys where at least one child was present was higher than average. These households are making less single occupancy car trips, which is a positive. These households are also travelling by active modes of transport more frequently. Some of the one car households who travel by sustainable and active forms of transport on the weekdays tend to travel mostly by car at the weekend. This may be because having only one car forces certain members of the family to seek alternative modes of transport for the school run/work trip, whereas at the weekend the households tend to travel by car as a family for trips, so they don't consider the alternative sustainable modes of transport. A potential intervention could therefore target the one car households who are already choosing to travel sustainably on the weekdays but may not have considered switching to alternative modes of transport to the car at the weekend. Households with two or more cars had an average or higher than average total car use for the four days in minutes, and total walking time was also much lower than the average in these families.

Households with an older child living in the house are driving more than the average, and for a high proportion of these journeys a child is not present. These households are also walking less and driving short distances often. There is scope for increasing active travel within these households.

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