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Citation: Thomas, Lisa, Briggs, Pamela and Little, Linda (2010) The impact of using location-based services with a behaviour-disordered child. In: The 6th Nordic Conference on Human-Computer Interaction, 16-20 October 2010, Reykjavik, Iceland.

URL: <http://dx.doi.org/10.1145/1868914.1868971>  
<<http://dx.doi.org/10.1145/1868914.1868971>>

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# A Case Study: The Impact of Using Location-Based Services with a Behaviour-Disordered Child

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## ABSTRACT

In this paper we explore technologies that help parents locate their children. Parents regularly use mobile phones to stay in touch with their children, but recent developments in location-based tracking allow parents to assess the location of their child directly. Such location-based services offer new assurances, but also bring new privacy challenges. In order to explore these, we conducted a case study focussing on the way in which a family has used location-based technologies to keep track of a child with Aspergers Syndrome and Attention Deficit Hyperactivity Disorder. This novel research shows that Location-Based Services, although usually applied to lone-worker situations, can be effectively applied to other user groups. The parents of the child were interviewed at length, and the interview was analysed using qualitative methods. The findings are discussed and considered against a current predictive model of LBS use.

## Author Keywords

Location-Based Services, Parental Monitoring, Assistive Technology.

## ACM Classification Keywords

H.1.2 [Models and Principles]: User/Machine Systems - *Human factors*.

H.5.2 [Information Interfaces and Presentation]: User Interfaces - *User-Centred Design*.

J.4. [Social and Behavioural Sciences]: Psychology.

K.4.2 [Computers and Society]: Social Issues- *Assistive Technologies for Persons with Disabilities*.

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*NordiCHI 2010*, October 16–20, 2010, Reykjavik, Iceland.  
Copyright 2010 ACM ISBN: 978-1-60558-934-3...\$5.00.

## INTRODUCTION

### Parental Monitoring

An essential part of being a parent involves knowing where your child is, what they are doing and who they are with. The monitoring of children by their parents has been promoted as a way of reducing the probability of behaviours such as alcohol and drug use, risky sexual behaviour and delinquency [11]. Stattin and Kerr [11] propose children are monitored in three distinct ways: child disclosure (the child will volunteer information), parental solicitation (parents ask their children for information), and parental control (imposing rules and boundaries on the child). However, their research suggests that information gained by parents most often comes from child disclosure; what the child tells them, not from parental monitoring.

With the advent of mobile phones, it has become easier for parents to be aware of their child's location; they call them and ask where they are. Yet this instant communication tool is not always used as it was designed. In one study of mobile phone use in the Czech Republic, teenagers spoke of deception or ambiguity when receiving unwanted calls from their parents, saying their phone battery had run out, they had no signal, or had no credit [13]. Research has also shown that a greater frequency of parental calls leads to less adolescent truthfulness [14], suggesting that parents should establish norms of expected behaviour which could enhance the parent-adolescent relationship. This reiterates the findings of [11] who argue that more information will be gained when the child is allowed to initiate communication.

### Monitoring and Technology

Technology is now used as a trusted tool to ensure child safety. For example, parents now use mobile phones more often to communicate with their children, although effective rules of engagement may not be firmly established. Technology has also been suggested for the monitoring of young children using Location Based Services [9]. Location Based Services (LBS) are defined as "services that take into account the geographic position of an entity" [6]. Marmasse

and Schmandt [9] developed a prototype to create a ‘virtual leash’ for a young child. This use of a mobile phone, with a Global Positioning System built in, allows a parent to specify where their child is allowed to roam. If the child goes further than the prescribed ‘zone’, an alarm will alert both parent and child until a more appropriate distance is achieved.

### Assistive Technology

The research discussed highlights how technology can help parents to monitor their children’s location. This type of technology would be especially useful for parents of children with varying cognitive or social deficits. Recently there has been an improved understanding of the ways in which technologies might bring some improvement into the lives of those with psychological disorders. For example, [2] emphasise the benefits of collaboration between HCI and medical professionals. Working collaboratively a 3D computer game was developed to aid communication between adolescents with mental health problems and their therapists.

Carmien, et al [1] have shown technologies can facilitate the execution of everyday activities for people with psychological disorders. Typically travel, transport and navigation can generate problems for behaviourally challenged individuals. Looking at ways to improve navigational skills on public transport systems, [1] suggested a navigational assistant to aid way finding. Their prototype GPS ‘Personal Travel Assistant’ was designed to be a synchronised prompting device, enabling the user to navigate and use transport without external aid.

Work by [3] explicitly looked at the uses of technology for adolescents with a cognitive disability. Assistive technology is used to describe ‘a technological device or software that has been designed to assist people with disabilities’. However, [3] points out that not all assistive technology is successfully adopted. Speaking to families with a cognitively disabled child, issues raised were related to the suitability of the technology and whether it matched individual needs. Technology was desirable if it was portable, easy to use, and had ease of upgrade. Parents often struggled to understand the technology, whereas the children became expert users. In one example, the child worked out how to erase settings on their communication device, requiring their teacher to reconfigure it all over again. In particular, independence was found to develop for some children but not all. Using mobile phones to contact their parents when they went out alone reassured the children, and subsequently the frequency of contact decreased.

These research findings [3] emphasize the independence that technology *could* provide. Despite many kinds of technologies being tested, LBS have not been specified as a tool to help people with a psychological disorder.

Similarly, relatively few studies of LBS have considered social and family contexts, and those that exist are predominantly focused upon a parents need to understand where their child might be [5]. In this paper, we explore the potential use of LBS in a family setting, where pressures on the family arise because of a son’s psychological disorder (Aspergers Syndrome and Attention Deficit Hyperactivity Disorder).

### Aspergers and ADHD

ADHD is a disorder characterized by atypically high levels of hyperactive/ impulsive behaviour and inattention [4]. Individuals displaying six or more of these symptoms for six months or longer are identified as i) ADHD, combined type if both symptoms of hyperactivity/impulsivity and inattention are present ii) ADHD, predominantly inattentive if only symptoms of inattention are present, or iii) ADHD, hyperactive/impulsive if only high levels of hyperactivity/impulsivity are present. The different stages of ADHD and their disruptive potential are described in Figure 1.

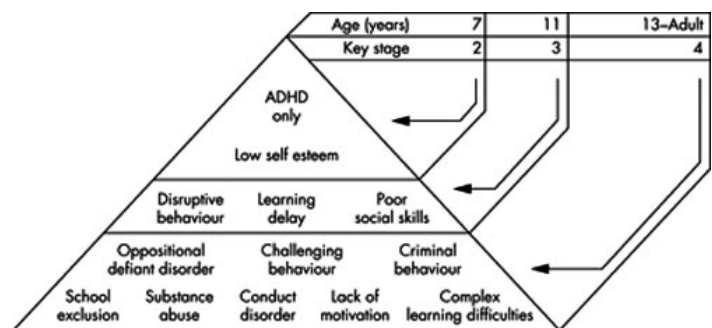


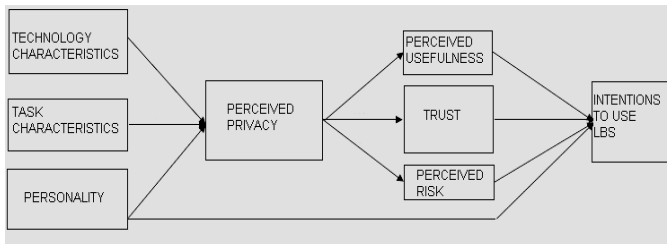
Figure 1: Impact of ADHD at different stages, adapted from Kewley [8]

The Diagnostic and Statistical Manual [4] criteria for Asperger syndrome, also called Asperger disorder, include: impairment in social interaction; restrictive, repetitive and stereotyped patterns of behaviour, interests and activities and significant impairment in social, occupational, or other important areas of functioning. Adolescents with Asperger Syndrome have been identified as a subgroup in particular need of support as these young adults frequently experience low self-esteem, and have to deal with a range of health concerns that include depression and anxiety [12].

Both ADHD and Aspergers have different symptoms, however the social and family impact on the individual with these psychological disorders are of most relevance in this case study. This study investigates the impact on the family these psychological disorders have, and how the use of LBS affects their daily lives.

## A Research Model

Although there are no existing research frameworks that might help us understand the key issues involved in using LBS in the context of a behaviourally disordered child, there is, nevertheless, a research model (Junglas & Spitzmüller [7]) that highlights factors predictive of intention to use LBS. This model is outlined in Figure 2.



**Figure 2. Research model from Junglas & Spitzmüller [7]**

This model aims to predict what factors will influence the uptake of LBS:

- Technology Characteristics are categorised into location-tracking and location-aware. Location-aware services can enable the user to benefit from their surroundings, as the LBS device has knowledge of its own location. Location-tracking services provide information to an entity other than the user. It is location-tracking which is assessed in this case study.
- Task Characteristics at the time of LBS usage may affect the way individuals perceive a tracking system.
- It is hypothesized that personality type will affect usage—more conscientious individuals will be likely to use LBS, individuals scoring highly on neuroticism may be more likely to distrust LBS systems, and individuals more open to experiences are likely to have fewer LBS concerns [7].
- Four privacy items are identified relating to information exchange: collection of personal information, unauthorized secondary use of personal information, errors in personal information, and improper access to personal information [10].
- Perceptions of Usefulness are said to increase after initial usage of LBS [6]. Usefulness is also influenced by beliefs about privacy.
- Research into trust has divided the concept into three categories: Benevolence, Ability and Integrity. Benevolence reflects the service provider’s positive image as viewed from a consumer’s perspective. Ability refers to perceived competence. Integrity refers to an organizations adherence to rules.
- Risk has been proposed as ‘inseparably intertwined’ with trust issues, and is therefore hypothesized to be a direct antecedent of intentions to use LBS [7].

We must recognise that those factors said to predict LBS uptake *in general* may not be relevant to the uptake of LBS under the somewhat unusual family circumstances that we describe – i.e. this model may have only limited relevance to the use of LBS to monitor a teenager with ADHD and Aspergers. However, there have been no other research frameworks that address the way that Location Based Services can help families in general, and such challenged families in particular. It is not the purpose of this research to test the model directly by predicting intentions to use LBS, but nonetheless, we will assess the extent to which this model is supported by the findings of this particular case study.

## METHOD

### Participants

Participants were two adult parents (1 male, 1 female) of a 16-year-old male with ADHD and Aspergers Syndrome. There was also a younger teenage son within the household, but he was not involved in the trial, and had no behavioural problems. Also present were two employees of the Digital Challenge Programme, a partnership of public, private and community sector organisations linked with Sunderland City Council, UK. These employees were present in order to gain a more in depth understanding of how their intervention had helped. The family had been using the LBS system, provided by local company TrackaPhone, for approximately 4 months.

### Materials

The parents and child were each given a BlackBerry™ on which the TrackaPhone software was linked. The BlackBerry™ was theirs to keep and use during the trial. An example of the TrackaPhone location system on the BlackBerry 8800 can be seen in Figure 3. The BlackBerry™ was enabled to allow the user to make and receive phone calls as normal. This equipment was offered to the family for as long as they wished to use it. At the time of interview, there were no plans to return it to the vendor.

### Software

The TrackaPhone ‘People Locator’ system was set up throughout the trial on the BlackBerry™. This system enables a person to locate an individual instantly using cell ID. The system also included ‘Alert Client’ (see Figure 3). Alert Client enables panic buttons and escalation procedures to be used via the TrackaPhone platform. A red alert display indicates the person is in danger. This system allowed the parents to be alerted to these alarms if triggered by their child. This aspect of the TrackaPhone software differs greatly from commercially available services such as Google Latitude, which have no alarm system or inherent safety features.



**Figure 3.** A BlackBerry 8800 displaying a typical location map (left), and an example of the Alert Client: ‘Red Alert, Amber Alert, Delay Amber, Cancel Alert’ (right).

### Procedure

The parents were briefed and told this was an exploratory case-study to investigate attitudes and experiences of using location-based services within the family. An unstructured interview was carried out at a neutral location for all parties, and took two hours. Participants were allowed to talk at length, and prompted where necessary. The interview was tape-recorded with permission from the family. The interview was then transcribed verbatim.

### RESULTS

The transcript was read, re-read and coded using theoretical thematic analysis. Coding was partly driven by the preconceived areas of interest based on the model, but was not restricted to them. Codes were then organised into themes. To aid the coding and theme organisation, NVivo qualitative software was used. Thematic analysis produced a number of key themes from initial coding. These are discussed below and summarised in Table 1. (‘M’ beside a quote refers to the mother, and ‘F’ for the father respectively). The pseudonym of ‘Steve’ has been used to refer to the teenage son.

Theme	Codes relating to the themes
Navigation	Notion of zones, Way finding, Routine, Being Lost
Anxiety	Deception, Stress, Parental Concern, Money
Well-being	Reassurance, Trust, Safety, Privacy Vs. Safety
Personality	Distraction, Behaviour Without Medication, Getting In Trouble, Communication
Personal Development	Confidence, Encouraging Independence, Increased Boundaries, Helping Others
Freedom	Child’s Freedom, Parent’s Freedom
Technology Adoption	Respect, Usability, Reciprocal Tracking

**Table 1.** Main themes and individual codes.

### Navigation

Most overtly, the family emphasised problems with their son’s navigational skills, causing him to frequently get lost. They talked of driving round in the car looking for him, before they had the aid of LBS. The parents talked of the BlackBerry enabling them to pinpoint where their son was, which saved time searching for him. Previously this frequent habit of getting lost impacted on the places the family allowed their son to go to, resulting in a restricted routine for him. Before using LBS, Steve’s routine mirrored that of his brother’s, who he used to copy to ensure he got home safely. The family discussed problems with their son not coming home when he should, but since the implementation of LBS they described how he was developing his own psychological as well as physical ‘safety zones’ in which he could travel without fear. The LBS system encouraged him to take notice of where he was, and knowingly plan where to go himself:

*F: “He’s starting to plan his routes, that’s what he’s doing.*

*M: He’s planning ahead, whereas normally we have to plan ahead for him”*

Planning routes was previously extremely difficult for Steve. Therefore utilizing this technology, designed to provide exact location information both to the user and the ‘tracker’, helped Steve overcome some of his previous problems. He was said to be able to self-manage, in part by

sticking to routines. The LBS system, in this case, provided both location-aware and location-tracking services that parents and child found useful. For Steve, LBS was used to pinpoint his own location. His parents used it to track him and navigate their route towards him if lost.

### **Anxiety**

Prior to the introduction of the LBS system, the parents experienced immense stress at times when their son went missing. They described this as a constant worry, with stress reactions in the mother including vomiting, weight-loss, and a reluctance to leave the house:

*M: "With me vomiting all the time and the stress and everything, I was losing the weight and I wouldn't leave the house for him because I knew he'd come back either by the police, or I'd have to look for him"*

Any change in Steve's routine was likely to trigger such stress reactions and the parents gave examples that included anxiety over a change in school and feelings of apprehension about their child going to college. These stressful reactions were not eased by Steve, himself, being deceptive. His parents said he often lied or withheld the truth about where he was going, although introduction of the tracking system meant that he was readily discovered: for example, Steve's mother discovered he had avoided a swimming lesson when she observed he had taken his Blackberry out with him:

*M: "I think that's why I did have that instinct. I thought he's taken his swimming trunks and a towel, and he never takes his tracker. I was sitting in the garden and thought 'I'll just check where he is'"*

Understanding Steve's routines, his mother realised he was not where he was supposed to be. Use of the LBS system simply confirmed this suspicion.

As a by-product, the introduction of the LBS system caused Steve to be more truthful, or rather, convinced him that deception was pointless, i.e. he realised he couldn't effectively deceive his parents about where he was going. This helped alleviate parental anxiety (although didn't remove it completely). However we know that deceptive behaviours are commonly found in teenagers [13] and so it is worth noting here a set of complex issues about (i) the extent to which technologies can highlight deceptive behaviours and (ii) whether such deceptive behaviours should be suppressed or supported.

### **Well-Being**

The LBS system provided reassurance, for both the parents but also for their son. They noted that Steve often worried they would not be able to find him. They were reassured knowing where Steve was, but they could also reassure him that they could find him wherever he was:

*M: "I had to reassure him, but he felt safe knowing that I'd find him. He didn't have to explain, he just said 'I'm with...' such and such, at Hollycarside"*

The use of the system also seemed to slowly build up a new kind of trust between parent and child. Steve's parents discussed how they used to accuse him of things because they had no way of knowing where he had been. Steve also learned when he needed to take his Blackberry out and when he could leave it at home:

*M: "But he still has kick offs and major disruptions, that's Steve, but with the Blackberry he's like, I think it's a trust. He's learning to go that far and be trusted and he's more relaxed when he comes back. He's thinking well I'm able to do it. And it's not a constant battle against each other"*

This development of more independent thinking was prominent throughout the interview. Both parents said the technology made them feel safe. Further to the safety of their son, Steve's parents talked about potential applications for the technology to ensure safety in wider society:

*F: "If you were to offer this to people and say well listen you can have Trackaphone but it's gonna cost you £1.50 a week, for a child, you'd have millions of people would take it"*

Safety was viewed as being of more value than privacy in the case of children. There was no mention of location information getting into the wrong hands, which is often cited as a concern in the literature. The parents explained that they were not worried where their son was at every minute of the day, but would use the system occasionally at their discretion to maintain a level of safety:

*F: "The thing about privacy really is, it's not like we're sitting at home in front of a computer and we track every move he makes. We look at it occasionally, it's like 'right, I wonder where he is'. That's it"*

Steve's father believed that if PINs or passwords were put in place, the LBS system could benefit other families with at risk children. He also mentioned a number of high profile murder and abduction cases, which in his opinion, could have been avoided if parents were offered the opportunity to use this type of technology. Interestingly the family agreed however, that the usefulness of the system would eventually be outweighed by a need for privacy, and at the age of 18 their son would not be using the system. In relation to their other son, the family described how they had suggested he borrow his brother's LBS system when he went out. Despite him being younger, he was said to be more streetwise and private:

*M: "I said 'you can take your brothers Trackaphone out with you if you're going out'. He said 'you've got no right tracking me, it's up to me where I am'. And he's got a point"*

This type of anxiety about privacy does not relate to the kind highlighted in the LBS model. In the model privacy is related to information disclosure and the potential for information loss. The concern of this family was the privacy violations their son may feel whilst being located by them.

### **Personality**

Becoming distracted emerged as a major problem for Steve, as he would get lost after following somebody or something. Going for a walk or getting on a bus was described as challenging. His disorder also caused problems with simple tasks such as brushing his teeth or putting shoes on. However, with the use of LBS Steve was said to think for himself more. This independent thinking and increase in responsibility affected his medication dosage. Steve's parents felt the future was uncertain, but that the LBS system had certainly helped:

*F: "Yeah, the medication's slowly going out the window as in he's not on it as much, whereas before we would have to make sure he took it to concentrate"*

With the development of initiative and the realisation that his parents were giving him more freedom, the technology was said to help communication between parent and child. The 'intercom' feature on the BlackBerry enabled Steve's parents' instant verification of his whereabouts. This act of affirmation was also reciprocated by Steve:

*M: "He went 'I've missed the number 3 bus, I'll be back home in about 45 minutes' but it wasn't even past his time, I didn't even expect him home. But he must have just panicked and thought 'I'll phone me mam'"*

The LBS system also had an Alert Client (see Figure 3.) that was used two or three times to signal that Steve was in trouble. Steve could use this if he felt intimidated or bullied, but the family also explained its potential for use in absolving Steve of blame: they noted that his disability meant that he could be falsely accused of misconduct. The LBS technology allowed them to keep a three month history of his movements.

### **Personal Development**

During Steve's use of the LBS system, his parents reported that he developed a noticeable growing confidence:

*M: "But I mean his confidence, he's gone into a normal teenage lad that he should have been when he was 12 or 13. I've got two teenagers"*

His parents also talked of Steve feeling empowered when he had the LBS system. This confidence naturally led him to become more independent. With this independence he was able to go out alone without fear, use public transport, and visit friends:

*M: "With this [Blackberry] I haven't got to be there 24/7. He's started doing everything his self. He's starting to think for his self a little bit better instead of me reminding him constantly"*

The family talked of Steve pushing boundaries and expanding his social network. This change in behaviour still carried an amount of risk, and his parents hinted that they occasionally worried and would check his location. However in general the risks associated with giving Steve more freedom was outweighed by the benefits of his personal development. This development was linked with trust; his parents acknowledged that he needed to be trusted to go out and come back on his own. The LBS system also enabled Steve to adapt his behaviour. He was said to become more observant and aware of his own surroundings. He also learned how to deviate from pre-existing routines to suit his plans. An amount of this growing trust and independence was to prepare for Steve going to college. His parents wanted him to be self sufficient and able to cope travelling alone. Steve not only accomplished this with use of the LBS system, but also became an aid for other students travelling to school.

### **Freedom**

Despite constraining Steve's use of deception (see above), the use of the LBS system brought new freedoms, both for Steve and his parents. They said Steve was getting more of a social life, he was allowed out more during school holidays, and spent more time with his friends and wider family. What became evident was the freedom that the technology also offered his parents. The reduction in worry meant that his parents could go out together. There was a sense of re-learning how to spend time together and also develop as individuals:

*M: "We've started to do things together, whereas before it used to have to be separate, one of us went out, one of us stayed in. And I'm going on courses now which I couldn't before because I wouldn't leave him [her husband] with all of it"*

### **Technology adoption**

The technology was adopted well by the family, and only minor issues arose in relation to usability. In a pressured situation, Steve's mother described how she reverted to old methods of communication before they had the LBS system:

*M: "There has been one time when he's [Steve] pressed the alert button, and I've panicked and phoned his mobile. And that's my quickest way. Because by the time I've remembered my pin and put the pin in (the blackberry) I panic, as a mother does, I just panic"*

Steve was said to have taken to the technology well, and

often guided his parents in how to use the BlackBerry. One result of his technological ability resulted in Steve tracking his parents when *they* went out. This gave peace of mind to both parent and child in order for them to leave him at home without worry. Such reciprocal use of tracking technologies is particularly interesting in the way it can alleviate power imbalance and helps to address some of the privacy concerns naturally thrown up by LBS technologies. Unsurprisingly, Steve's parents expressed the view that privacy concerns were less important than safety concerns – but reciprocity in the use of LBS to track both parent and child meant that loss of privacy worked both ways.

Steve was said to have demonstrated a respect for the technology, understanding that it was the reason he was being trusted and given more freedom and showing sense in sharing it with others:

*M: "He doesn't take it to show it off to his friends or anything, or text in front of them. He has taken it out when he's needed it. Phoned his emergencies, then put it back in his pocket. Cos you'd get some kids 'oh I've got a new phone'. He's not like that with it. He knows it's his independence"*

## **ANALYSIS AND DISCUSSION**

This study raised some important insights into how LBS might be introduced into the lives of families where there are children with psychological disorders, but perhaps the first thing we should note is that, understandably, the themes that emerge in this study are rather different from those that dominate the existing LBS literature.

Perhaps the key difference is the emphasis on privacy, which is generally considered one of the key factors in predicting uptake of LBS services and is certainly a major factor in Junglas and Spitzmüller's model described earlier [7]. Our own findings say relatively little about privacy – but perhaps this is to be expected in a study that places the family at the centre of investigation. Within families in general, and this family in particular, children's privacy needs can and do conflict with parents' responsibilities. For our particular family, those parental responsibilities have essentially become burdens, tied to acute anxieties that have since been alleviated by the use of an LBS system. Our parents did recognise the need for a teenage boy to be able to have a private life of his own, but privacy violations were accepted as a reasonable price to pay for peace of mind. On reflection, then, while privacy management is probably one of the first things to get right in a workplace LBS system, it may not be of paramount concern in the design of a family based system, where the parent will assert their right to protect their own child as their prime concern.

Existing LBS work, and particularly the most complete current model [7] also places significant emphasis upon the 'perceived usefulness' of a system. However, the model

offers little in understanding the ways in which an LBS system may be perceived as useful. We interpret 'perceived usefulness' in a very liberal sense – in the current study, not only did the LBS system prove useful in enabling Steve's parents to locate him instantly (the initial aim of the system), but it also succeeded in a more fundamental goal: that of giving both parent and child more freedom. In this family context, then, the system proved useful to the parents, who were able to socialize with friends and go out more and to the child, who gained in confidence and who was able to spend more time away from home. In other words, the use of the LBS system led to a significant growth in personal development and improved well-being for all family members. Such significant added value is not something usually associated with an assessment of the 'usefulness' of an LBS system, yet, within the wider context of assistive technology, outcomes such as dignity, enhanced independence and wellbeing are often important development goals. In this sense, too, it is worth noting that one of the classic aims of those working within an 'assistive technology' paradigm is to use technology to overcome the limitations of the human mind and body [1] thereby releasing the individual from the constraints of impaired functioning. We have only just touched upon the capacity for LBS technologies to do this in the context of a behavioural disorder, while we acknowledge that such 'freedom from limitation' is absent in the bulk of the LBS literature and is certainly not one of the classic interpretations of 'usefulness'.

## **FUTURE WORK**

The case study presented here raises interesting questions about the value of LBS services in different contexts. Away from the workplace, the introduction of LBS can prompt fundamental changes in respect of autonomy and freedom, personal responsibility and growth, peace of mind and psychological wellbeing. Following on from this study, our planned investigations of LBS in the wider context will include a study to assess the potential costs and benefits of LBS use in a group of older adults. We are currently in discussion with a group of people, mostly in their eighties, who are available to trial a similar LBS system. This work is part of an ongoing three year PhD project that has the aim of improving our understanding of successful and unsuccessful LBS use across a range of contexts.

## **CONCLUSION**

We have presented a case-study that describes the introduction of LBS technology into the life of a family with a very challenging child. This case is not typical of other LBS contexts of use found in the research literature. Yet our study reveals a remarkable success story for LBS in terms of improving the quality of life, wellbeing and confidence for family members. We see this rather 'extreme' case study as instructive in three important ways:



firstly, it allows us to redraw the parameters for uptake of LBS, moving research away from workplace models; secondly, it allows us to question the conditions under which LBS might be successfully employed, particularly in terms of privacy requirements; and thirdly it allows us to redefine the goals of LBS, expressed not simply in terms of 'useful' or not, but in terms of more fundamental human values: freedom, wellbeing, independence and personal growth.

## ACKNOWLEDGMENTS

We thank TrackaPhone, Ray Sherrington from the Digital Challenge Programme, Sunderland City Council, and the family involved in this case study. This research was funded by an ESRC CASE award.

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