Monitoring Children's Physical Activity and Sleep:
A Study of Surveillance and Information Disclosure

Mikkel S. Jørgensen, Frederik K. Nissen, Jeni Paay, Jesper Kjeldskov, Mikael B. Skov
Department of Computer Science / Research Centre for Socio+Interactive Design
Aalborg University, Aalborg East, Denmark
{mikkel.skare, frederikkastrup}@gmail.com,{jeni, jesper, dubois}@cs.aau.dk

ABSTRACT

Children and parents build mutual trust through voluntary disclosure, but at the same time parents are guardians who monitor and guide children as they grow up. Emerging technologies offer new opportunities for parents to monitor children while being separated. We investigated how sleep and physical activity data from a Fitbit Flex wristband worn by children (aged 9-12 years) were shared in families over a five-week period. We discovered that the children would optimize their data as they learned more about their own activities, and then started pleasing their parents as a result of being under surveillance. Interestingly, we also saw that parents used the physical activity and sleep data to question children about specific activities, and while this increased parental control, it reduced spontaneous and voluntary information disclosure from the children about their daily activities. This appeared to negatively influence the trust between the children and their parents.

Author Keywords

Surveillance, children, parents, disclosure, trust, activity, tracking, sleep

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

As we leave more and more digital footprints while using mobile technology, we increasingly face issues related to surveillance. In 2014, a survey showed that 40% of Danish parents of children aged 0-15 years old found it acceptable to monitor their child's location through GPS technology, and 30% of these parents would actually consider installing a location-tracking app on the mobile phones of their children. While this causes controversy, it also shows that as mobile technology evolves and gives us new possibilities for monitoring other people, we are faced with new challenges of surveillance, disclosure, and trust. There are

Figure 1: One of the participants wearing the Fitbit Flex™ wristband during the study.

numerous information and communication technologies that enable parents to monitor children without the children's knowledge. Using such existing technologies, parents (and others) can get information and data about children on for example their whereabouts, their activities, or their actions. As an example of a commercial product, the PC Tattletale (PC Tattletale, 2016) provides parents with the ability to record, monitor, or limit children's online activities, stating on its website "… *your son or daughter will have no idea that you are watching their every move* …". Other tools provide parents with data about their children's location, allowing them to track children's physical movements (Vasalou et al., 2012).

The use of monitoring technologies raises obvious concerns in relation to trust. Family trust between children and their parents is a vital part of family wellbeing, and parental trust in adolescents is often based on knowledge of the child's daily activities (Dalsgaard et al., 2007; Kerr et al., 1999). With the use of monitoring or surveillance technologies, parental knowledge can possibly be supplemented with, or built on, monitored data.

While trust has long been a voiced concern within the field of HCI (e.g. Graham et al., 2004; Torremante et al., 2015), few research studies investigate the impact of monitoring technologies in real life. Until now, research studies have considered digital parenting in relation to location tracking (Boesen et al. 2010; Consolvo et al., 2005; Rode, 2009) or to children's digital lives (March and Fleuriot, 2006; Yardi and Bruckman, 2011) and more recently how house locks and security cameras affect teens' privacy (Ur et al., 2014), but we have seen limited research focusing on surveillance or monitoring of children's more daily activities using technology and how this affects mutual trust.

In response to this, we studied sleep and physical activity data from an activity-tracking wristband worn by children

(aged 9-12 years) and shared this data in families over a five-week period with the children's knowledge of what was being shared. We were particularly interested in studying how monitoring affected the relationship between children and parents, how parents would act upon such data, and how children would behave knowing that their parents were monitoring them.

Our contributions are two-fold. First, we provide detailed qualitative insights on how parents engaged with the collected Fitbit data and how they interpreted the children's activity and sleep data and question their children, but also how the children would optimize behaviour and actively use data in their own favour. Secondly, we illustrate how trust is affected and discuss how the collected activity and sleep data decreased parent uncertainty. At the same time, it reduced spontaneous and voluntary information disclosure, which seemed to negatively influence the trust between the children and their parents.

RELATED WORK

In this section, we outline and discuss research on human-computer interaction and surveillance and trust particularly in relation to children and parents.

Trust and Distrust between Children and Parents

Trust between parents and their children is crucial and has been investigated in several studies. As an example, Vasalou et al. (2012) argue that when moving towards adulthood, children must develop independence both in thought and in action, and normally under parental direction and control. They explain that this is not a trivial task for parents, as they must balance the control required in protecting their children with the openness that allows the children to explore their environment in order to develop self-direction. Kerr et al. (1999) found that parents who gain knowledge about their children's daily activities trust their children more, but this is only the case if the knowledge is obtained through spontaneous and voluntary disclosure from the children. When behaviour is regulated through extrinsic forces (e.g. fear of punishment), children are less likely to internalize the values of reliability and honesty (Kerr et al., 1999). Further, Mayer (2003) found that uncertainty might also be essential in order to display trustworthiness in the first place, as trustworthiness can only be displayed when the possibility of untrustworthiness exists. Thus, parents who utilize surveillance technologies as part of parenting may actually not end up trusting their children more; on the contrary the use and application of surveillance technology might even make them trust their children less.

Technologies and Surveillance in Families

Emerging technologies increasingly enable monitoring and surveillance as they become mobile and portable, integrate new features and functionality, e.g. GPS, accelerometers, while at the same time being connected and online. Several research studies have investigated the role of technology for surveillance in families and often studies demonstrate that surveillance technology is motivated by uncertainty or concern about children's safety (e.g. Czeskis et al., 2010; March and Fleuriot, 2006; Rode, 2009; Yardi and Bruckman, 2011, Ur et al., 2014).

Yardi and Bruckman (2011) discovered that parents find it difficult to understand or interpret how and why children use technology, and thus how they should as parents set rules and boundaries for effective parenting. Some parents would monitor Internet use by requiring password information or requiring that they be Facebook friends. Some would even forward children's emails to their own email addresses without their children's knowledge. Rode (2009) found in a study involving 12 families that several parents found their child's Internet activities threatening and therefore defined and declared off-limit activities. Rode argues that the perceived gap between the expertise of parents and children undermines parental authority. Also, March and Fleuriot (2006) studied teenage girls' online communication and found that girls preferred non-public PCs when communicating privately either via text messages or using instant messaging and the girls found their mobile phones to be private technologies.

But the use of technologies for monitoring and surveillance is not uncomplicated. Gammon et al. (2005) discovered that parents were likely to ask their children about diabetes management if they had access to extra information and that surveillance technology used to track diabetes related aspects of a child's activities could represent an additional source of tension and in turn a negative parent-child relationship. Toscos et al. (2012) argue that parents using these new tracking developments in health monitoring technologies, risk crossing personal boundaries that might cause conflicts in the parent-child relationship. However, they argue that there is still much to understand about the impact of using remote health monitoring technologies given the potential adverse effects on the family dynamics. Mancini et al. (2011) stress that social contracts within close relationships and tracking technology possibilities can create anxieties and inner conflicts that may compromise relationships. However, other studies have shown that monitoring technologies hold promising benefits as family members experience positive gains from aspects of reassurance, connectedness, identity and social touch [3]. Thus, equal monitoring can promote family identity and connectedness.

Bentley et al. (2007) discovered that participants would use certain information to infer location and activity of other people. As with the study by Mancini et al. (2011), this study allowed plausible deniability, as it could not supply users with absolute location information and therefore did not risk making people feel uneasy about the privacy implications. As such, few privacy concerns were raised during the study. In fact, as the participants were in close-tie relationships, they wanted to share even more information with each other.

Participant (Girl/Boy)	Age	Sports Activities	Parents in household (age)	Parents Occupation	Fitbit (duration)	Sync. Device
G1	11	Soccer (2x/week) Gymnastics (2x/week) Swimming (1x/week)	Mother (42) Father (45)	Psychiatric nurse and engineer	30 days	Own (iPad Mini)
G2	9	Swimming (2x/month)	Mother (39) Father (35)	Nurse and renovation worker	28 days*	Mother's (iPhone 5)
G3	10	Soccer (2x/week) Swimming (1x/week)	Mother (48) Father (49)	High school teacher and academic worker	29 days	Own (iPad mini)
G4	11	Soccer (2x/week) Girl scouts (1x/week)	Mother (39) Father (42)	Nurse and chief of economy	33 days	Own (iPad 4)
B1	12	Badminton (4x/week) Ice skating (1x/week)	Mother (44) Father (47)	Senior researcher and marketing chief	35 days	Own (iPhone 5)
B2	12	None	Mother (42)	Flexible job	19 days**	Own (iPhone 5)
B3	10	Karate (2x/week) Skateboard (every day)	Mother (41)	Administrative officer	36 days	Mother's (iPhone 4S)

Table 1: Demographics of participating children and parents. Remarks to the table: *Broke her arm after 4 days into the study but participated in the entire period **Lost the Fitbit wristband after 19 days of use.

STUDY

The purpose of the study was to investigate monitoring and information disclosure between children and their parents and more specifically to study sleep and physical activity. Inspired by a study on interpersonal trust between children and parents (Rotenburg, 1995), we chose preteen children (9-12 years) as in this age group they become more and more independent and spend an increasing amount of time away from the home and their parents. Therefore parental trust usually grows in importance (Kerr et al., 1999). We chose an off-the-shelf wearable mobile activity tracker called Fitbit Flex™ (hereafter referred to as Fitbit), which has been studied for example self-trackers (Choe et al., 2014; Fritz et al., 2014). Fitbit tracks and records steps taken, active minutes, and sleep. In many situations, parents will monitor or guide physical activity (like active minutes) or sleep as an integrated part of parental rules for children in this age group. Therefore, we chose to include these two aspects of children's daily lives.

As our study involves surveillance and monitoring, we had some methodological considerations on ethics and consent before we started the study. For example it was important to us that the participating children understood what they were to participate in. We recruited the children and their families through postings on local public noticeboards and extended personal networks, and none of the recruited families were acquainted with the researchers who conducted the study and interviews. First, the children received a participant information statement about the study before agreeing to participate (which we also explained to them orally). The statement included information about their role in the study, e.g. they should wear the Fitbit for approximately one month, the Fitbit tracked steps, active minutes, and sleep, and the logged data would be shared with their parents (and the researchers). Further, it outlined the interview plan, information about confidentiality, and that they could quit the study at any time. Secondly, the children signed a participant consent form (or an assent form as they are minors) together with the principal researcher. Afterwards, parents signed the form as legal guardians, but also as study participants.

Participants

Seven children (four girls) from seven families with twelve parents participated in our study. The children were between 9 and 12 years old (M=10.7) and they lived in close proximity to the city of Aalborg, Denmark. They were enrolled in primary schools from 3rd to 6th grade and six of them regularly participated in sports activities after school (e.g. swimming, gymnastics). In two families, the parents were divorced and the children lived primarily with their mother. Six children had siblings (see table 1).

All children lived close to the school they attended (within 500m to 2km) and most of them either walked or biked to school. The parents worked in various employments, e.g. nurse, labourer, engineer. Five children used their own smartphone or tablet for synchronization with Fitbit, while two used their mother's smartphone. See table 1 for further details. None of the families had used Fitbit or similar technology prior to the study. The families received a 150kr cinema voucher (~US$25) upon completion of the study.

Procedure and Data Collection

During four to five weeks, the seven children were encouraged to wear the Fitbit wristband as much as possible. Thus, they should try to wear it day and night and only take it off when recharging the battery. The parents had access to the data of their own child through a Fitbit account and they could login using mobile phones or PCs to access the data at any time. During these weeks, we held

three meetings or interviews with the families where six families chose to be interviewed at home while one family chose to be interviewed at the mother's workplace. We refer to these interviews as: Deployment, follow-up and steering, and collecting experiences.

(i) Deployment: The primary purpose of the first interview was to introduce the families to the study and the Fitbit wristband. As part of the deployment, we helped install the Fitbit application on their smartphones and tablets. The child and the parents received information about the study and were asked to read and sign a consent form.

We conducted a semi-structured interview to gain an initial understanding of the daily lives, activities, and routines of the participating families. First we interviewed the parents about the child's activities throughout the day and routines surrounding bedtimes. Subsequently, we interviewed the child to get his or her perspective on the same issues. Here we wanted to obtain an early impression of differences and similarities in perceptions of activity and sleep. The interviews took between 20 and 35 minutes and were audio recorded. We encouraged the parents to discuss experiences with the Fitbit during the study with their child. In order to help the families remember and capture their experiences using the Fitbit, we provided them with a personal diary, which we encouraged both parents and child to use.

(ii) Follow-Up and Steering: The purpose of this meeting was to ensure that the families were using the Fitbit and to solve any experienced technical problems. This part of the study ran during the four weeks of the study, and was at a slightly different time for each family. It consisted of two parts namely an interview and follow-up phone interviews. The primary interview was held approximately one week into the study.

During the five weeks, we contacted the families by phone if no activities were logged for the child over a whole day. In order to discover this, we would log in to the Fitbit website each day and check logged activities and events. Thus, in the end, we contacted the families twelve times (at least one time for each family) during the study where the primary reason for no activities or events being registered with the system was that the children had forgotten to activate or deactivate sleep mode. The second reason was that they forgot to charge either the Fitbit or the device for synchronization (e.g. smartphone or tablet). Additionally, the families contacted us eight times during this part of the study with questions on, for example, technical issues (e.g. was it safe to wear the wristband while swimming) and practical issues (e.g. one child broke her arm during the study and they wanted to change which arm she wore the wristband on). Finally, we texted facts from logged Fitbit usage data to the parents in order to encourage them to stay engaged in the study. These facts were playful in the way they were presented, based on the data logged and tailored to the individual family.

(iii) Collecting Experiences: The purpose of this interview was to understand the experiences the families had with

Participant	Average per day (SD)		
	Steps	Active minutes	Sleep
G1	9.229 steps (7063)	5 hrs. 22 min (141)	9 hrs. (58 min)
G2*	7.909 steps (4195)	5 hrs. 1 min (117)	8 hrs. 24 min (102 min)
G3	12.213 steps (6502)	6 hrs. 6 min (139)	8 hrs. 42 min (60 min)
G4	6.643 steps (4272)	4 hrs. 2 min (82)	9 hrs. 6 min (30 min)
B5	12.582 steps (9166)	5 hrs. 16 min (148)	8 hrs. 30 min (54 min)
B6**	10.224 steps (7064)	4 hrs. 30 min (89)	8 hrs. 24 min (36 min)
B7	8.156 steps (5520)	3 hrs. 50 min (111)	9 hrs. 54 min (177 min)

Table 2: Logged data about steps, active minutes, and sleep for the participating children

Fitbit. We collected the previously supplied diaries at the beginning of each interview. These diaries helped shape the interview as several parents had noted challenges when using the Fitbit. We conducted semi-structured interviews around five overall themes: functionality of Fitbit, usage patterns, interpretation of the data, impact of having access to the data, and sharing the data. The children and parents were both home when we interviewed them, but often the parents would attend to other things around the house while we interviewed the child, but they could oversee the session as guardians. All interviews were audio-recorded.

Subsequently, interviews were fully transcribed (188 pages total) and we immersed ourselves in the data through reading the transcriptions several times. We conducted a cooperative inductive thematic analysis to infer patterns and recurring themes in the data, which were later candidates for further qualitative analysis. Through repeated assessment, several topics and themes emerged.

FINDINGS

In this section, we present the findings from the study. All the names in the participating families have been anonymized, girls given a G prefix, and boys a B. Six of the participating children wore the wristband between 19 to 36 days (M=30), while one of the participating children wore the wristband for 19 days (he lost the wristband during school hours). During the study, the children would check the Fitbit data several times each day. One even reported that he would check it up to five times a day. All parents and children reported that they would look at the data both alone and together with others.

In the following we describe the steps taken, active minutes, and hours slept by the participants while wearing the Fitbit. The data can also be seen in table 2. We found that the average amount of steps taken per day varied greatly between the children ranging from 6643 steps to

12582 steps. Active minutes per day also varied between the children ranging from 3 hours and 50 minutes to 6 hours and 6 minutes. The highest number of steps taken and active minutes for one day was 39685 steps and 12 hours respectively, which were logged during a day of badminton tournaments by B5. The lowest number of steps taken and active minutes were logged by B6 and occurred on the same day, and he reported that he had spent an entire day in bed due to illness. We also identified days where no steps or active minutes had been registered, which was reported by the four families that it occurred with as being a result of the Fitbit wristband running out of power.

We found that the average amount of hours slept per day varied between the children ranging from between 8 hours and 24 minutes to 9 hours and 54 minutes. The highest number of hours slept was 13 hours and 45 minutes by B7 and the lowest number of hours slept was 2 hours and 30 minutes (G3). There where days where no sleep had been registered, which we have taken to be an equipment issue (e.g., forgetting to activate sleep mode) and these have been omitted in the calculations below.

Getting Familiar with and Using the Wristband

All seven children found the Fitbit wristband enjoyable to use and described the experience with words like "*fun*" or "*cool*". In particular, they liked to reach goals (e.g., 10,000 steps), as it made the LEDs on the wristband light up and made it vibrate. G3 explained how she felt when reaching the 10,000 steps for the day:

It was like: 'Now I've reached the goal for today!' That was cool! G3

While all children found the wristband enjoyable to use, some of them (2/7) expressed that the novelty faded after a few weeks mainly due to the fact that they could easily reach the goals in Fitbit (10,000 steps). But five children found the wristband and application interesting throughout the entire study. Here some of them argued that they had more data for comparison towards the end of the study:

I did not know much about it [how many steps he took] *in the beginning, but at the end it becomes more exciting because I had learned something about it* B7

The children described how they were trying to understand how Fitbit translated different types of activities (e.g., jumping on a trampoline) into steps and active minutes. For instance, they experimented with the Fitbit to see how many steps running around the table produced, and how many active minutes could be achieved at different sports activities. The children also investigated how fast their actions would be synchronized to their smartphone or tablet and how shaking their arms would be interpreted as steps by the wristband.

The children and their parents experienced a number of problems in the beginning of the study primarily related to charging the battery and activating sleep mode. As we had instructed the children to wear the wristband as much as possible, it became difficult to find a suitable time slot for charging the battery. While two parents mentioned that they would charge it during idle times (e.g., watching TV), many of the parents (5/7) said that they would charge it late in the evenings and then slip it onto their sleeping child's wrist when it was fully charged. Another challenge was the sleep mode where we found that only one family had managed to activate and deactivate sleep mode each day throughout the entire study period. This is perhaps not surprising, as this requires new routines and behaviors.

Data Surveillance versus Activity Surveillance

We observed that parents would monitor their children and they often attempted to use the Fitbit data to infer or learn about the children's activities or even mood. As part of the study, we enabled monitoring for the parents, as they could look up three different data sources of their children's activities, namely steps taken, active minutes, and sleep. As such, it is not surprising that we observed this kind of monitoring or even surveillance. Surveillance is typically the monitoring of behavior, activities, or other changing information of other people for the purpose of influencing, managing, directing, or protecting them (Lyon, 2007).

Most parents (6/7) explained that they had been curious as to how active their children were while at school, and that the Fitbit data provided them with these kinds of insights. One of them even mentioned that these insights allowed her to manage and potentially direct her child, which resonates with Lyon's definition of surveillance (Lyon, 2007). We found that most parents used the Fitbit data to infer or interpret the wellbeing of their children (e.g. mood, distress, and tiredness). For example, one mother explained how she used the data to infer her son's mood:

Well, if he logged in at school then I knew. If it had been good, then he is happy when he gets home. And then I knew that he came home and was. When it had vibrated or something like that B6 (mother)

Parents would also attempt to infer or understand distress in their children from the data. For instance, the parents of G1 explained during the interviews how they observed that their daughter had been restless for 45 minutes during one night, which made them anxious and wonder what had happened. But the daughter had just been to the bath, and if she had not told them, they would have kept speculating:

If she had not said anything, then we might have kept wondering what happened … did she have a nightmare or was it something else that caused her to wake up during the night G1 (mother)

Incomplete and abstract data made the parents worry, as they were not able to infer the reason behind it. This showed that the low-level Fitbit data is sometimes difficult to understand and act upon. This also became evident as the parents were much more interested in talking about the activities behind the data instead of the actual data itself (e.g., talking about an active football practice instead of 5,000 steps). For instance, the mother of B5 described how she valued the steps her son took at badminton practice

higher than the steps he took at home, as she knew they were two very different things activity wise.

Parents assigned meta-information (e.g., context and prior knowledge about the child) to the Fitbit data in order to infer what the children were doing or how they were doing. Two of the parents explained that having access to the data gave them a greater understanding of why their children behaved the way they did (e.g., why a child was tired during the day or in a bad mood), as they were able to map wellbeing to specific levels of activity and amounts of sleep. As such, these parents mentioned that the data could prepare them to deal with future scenarios involving (amongst other things) the tiredness of their children, as the parents would be able to predict these situations by monitoring their children's data beforehand.

Being under Surveillance: Action and Response
While all children mentioned that they would start to forget wearing the wristband after a couple of days, we identified a number of situations where the children were reminded of the wristband. Sometimes other children would comment or identify the wristband and also the wristband itself would vibrate when reaching certain goals (10,000 steps), which would make the children aware of wearing the wristband. The more they became aware of wearing the Fitbit, the more they started to think about being monitored.

We found that the children responded in two different ways to their parents being able to monitor their data and activity. Some children stated that they did not like it (3/7), while others indicated that they felt indifferent (4/7). Three of the children explicitly mentioned that they were uncomfortable about the fact that their parents were monitoring them and were able to see how active they had been during the day or how they slept at night. For instance, B7 explained that his mother was sometimes monitoring his data on steps and active minutes in order to see *"how much he was doing"*, and he characterized it as *"scary"*. He later compared it to *"stalker-like"* behavior:

It is like when you stalk someone, and then you know what he or she is doing. It is like she [his mother] *stalks me when she monitors what I am actually doing.* B7

Another example was B6 who described that his mother had started to come into his bedroom just before bedtime to ask him about the Fitbit data, and he said that she would either cheer or scold him *"then she makes a cheering sound or she makes a yelling sound."*

We were surprised to observe that four children did not mind that their parents had access to the logged data. These children did not themselves mention anything related to being under surveillance. For example, when asked how he felt about his parents having data access, B5 explained:

Well, I thought it was ok that they could also manage it [a Fitbit] and the sorts. Also, if I did not have access to my phone then I could use theirs to check the data. I found that to be cool. B5

From our interviews it became clear, that these children did not mind being monitored or under surveillance as they did not experience any consequences of the monitoring. The parents of two children rarely asked their children about the Fitbit wristband and the data collected. One of them (G2) mentioned, *"Dad does not actually know what to do with the wristband"*. Thus, these children never experienced any consequences of wearing the wristband in terms of parents questioning them or placing restrictions:

Well, I did not require it of him. It was not like he had to find something to do or something. Well, it was just to see what he did. It was not to twist his arm around his back and tell him to walk 10,000 steps tomorrow. I did not demand this of him B6 (mother)

Finally, some children used the data to support their story or convince their parents about behavior. For instance, B7 explained that he used the data to "prove" to his mother that he was actually awake at night, something his mother did not believe.

She believes much more in me after this. I might as well say she believes me a 100% more than she did before. Before she did not even think about that I told her the truth about me waking up at night at 5am. B7

We found that the children had two different reactions to their parents potentially monitoring their data. First, this knowledge could trigger the children to start being more active and thus get more exercise (e.g., walking longer routes to school) in order to raise their number of steps taken or number of active minutes. For instance, B6 explained how his mother would either cheer or scold him depending on his level of activity shown by the Fitbit application. This made him go for long walks with the family dog in order to increase the number of steps taken. His mother told us that she did not consider this behavior normal. She explained that he would usually only walk the dog when specifically told to do so:

No, he would only have done it [walked the dog] *in the past, if he had been told to do so* B6 (mother)

The second reaction was that the children would start to optimize their behavior (e.g., utilizing shortcuts for raising number of steps taken). For instance, G2 explained that she found that taking "small steps" and "running on the spot" generated a high number of steps, which she could then present to her mother.

Trust and Distrust
Parental trust in adolescents is usually based on knowledge and more specifically on knowledge of the child's past and present behaviors (Kerr et al., 1999). Our study showed that parents used the Fitbit data to learn about their children's sleep and physical activities, and they would also use the data to facilitate parental control (i.e., impose and support rules and restrictions). Kerr et al. (1999) describe parental control as imposing rules and restrictions that would require children to give their parents information about their whereabouts and associations before making plans.

We observed that Fitbit supplied parents with data that could potentially be used to impose rules and restrictions (e.g., bedtimes and not sitting in front of the computer the whole day) that would usually require their children to disclose this information. Parents of six of the children described how they would monitor and compare data from the beginning of the study to data from the end of the study, which increased their awareness of the child's day-to-day activities (e.g., how active they were during lunch breaks).

These parents would confront their children with the data, if they somehow felt the child was not disclosing such information. For instance, the mother of B6 had asked her son to walk the dog, but then she noticed that he had been particularly inactive one day (i.e., only walked a couple of steps). This made her think that he could not possibly have walked the dog. Later, she explained how she felt more confident in her son actually walking the dog when she told him to. This resonates well with Kerr et al. (1999) that a high degree of control might make parents more trusting because they feel that the child's behavior is highly predictable as it is under their control.

Parents of two of the children argued that Fitbit presented them with an opportunity to change their children's routines (e.g., bedtimes). However, sometimes the data allowed parents to see that their children were actually telling the truth. For instance, the mother of G1 asked her daughter how much she had slept during a gymnastics camp. The mother then proceeded to look at the logged sleep data in order to verify that this was really the case, as no strict bed times were enforced at the gymnastics camp:

Then she had this weekend with gymnastics camp and sleepover. We picked her up Sunday morning and checked when we got home. She told us that she had had seven hours of sleep. Then we talked about the fact that we could check whether it was consistent with what she had been telling us. Because we have not been able to have any control while she was out there. G1 (mother)

Parental trust is also strongly linked to spontaneous child disclosure (Lyon, 2007). B5's mother described how they used Fitbit as a common project. B5 was an elite badminton player, which requires a certain amount of training. She mentioned how her son told her about his training and the corresponding data from Fitbit.

We talked a lot about it. It was a little project we had together. I thought it went very well and B5 is very good at telling me and good at doing all these things. B5 (mother)

DISCUSSION
Our findings show that parents and children became aware of and used the possibilities of monitoring daily activities. Not surprisingly, the data sometimes reassured the parents on the children's physical activity and sleep, e.g. what they were doing or had been doing. This confirms findings from previous studies e.g. Mancini et al. (2011) who found that location tracking of children reassured parents. Also, often the children felt under surveillance and several of them

were very uncomfortable about this – again this is not surprising and has been shown in previous studies, for example (Boesen et al., 2010; Vasalou et al., 2012, Ur et al., 2014).

Most previous family monitoring research has considered location tracking (Boesen et al. 2010; Consolvo et al., 2005; Rode, 2009, digital lives of children (March and Fleuriot, 2006; Yardi and Bruckman, 2011), or home-entryway surveillance and privacy (Ur et al., 2014). We studied daily non-digital activities of children and found two observations that were surprising and that illustrate parts of our contribution. Firstly, it was interesting to observe how deeply engaged some parents would be with the data on sleep and physical activity, and how the parents would in fact use the data to question their children and sometimes request additional information and even impose new parental rules. Secondly, while some children were uncomfortable with the fact that they were being monitored closely by their parents, it was surprising and somehow interesting to observe that some children found the monitoring acceptable and even took advantage of it, either because the monitoring had no immediate consequences for them (no new imposed rules) or because the children used the data in their own favour, e.g. to prove their own case. In contrast, Ur et al. (2006) found that girls would avoid using public family PCs for private communication.

While these insights provide one contribution of our study, in the following we will illustrate how such monitoring technology influences spontaneous information disclosure and trust and how such data and data sharing affected children's behaviour and mobility.

Information Disclosure and Monitoring Technology
Our study highlighted aspects of information disclosure and perhaps the lack of voluntary and spontaneous information disclosure. In summary, we discovered that the *monitoring technology led to fewer opportunities for building trust between the children and the parents because it decreased the children's possibilities for being untrustworthy.* We will elaborate in the following.

As we discussed earlier parental trust becomes increasingly important, as children grow up and spend more time away from home. Kerr et al. (1999) argue that parental trust builds on knowledge of daily activities and this knowledge should come from voluntary and spontaneous child disclosure. However, because our parents had access to the Fitbit data, they already had knowledge about activities such as when and if their children had been active. Parents used this data to infer what their children were doing, or had been doing, and sometimes this would trigger them to ask the children questions or enforce rules or restrictions.

The monitoring using Fitbit data meant that the parents no longer needed to gain their children's trust in order to get access to activity information or sleep information. We saw that it would occasionally prohibit spontaneous information disclosure from the child, but provide the parents some sort of control. The latter resonates well with parental control as

illustrated by Kerr et al. (1999) who argue that a high degree of control might make parents more trusting because they feel that the child's behavior is highly predictable as it is under their control. This was identified in more situations for our participants. But it seems to come at a cost, namely that monitoring can lead to fewer opportunities for building trust between children and parents because trustworthiness can only be displayed if the possibility of untrustworthiness exists – as argued by Mayer (2003). Our study demonstrated that monitoring technologies decrease the possibilities for being untrustworthy.

Mobility and Monitoring Technology

The pervasiveness of wearable and mobile technology has resulted in several opportunities for both tracking and self-tracking, e.g. research studies have investigated wearable technology for self-tracking of fitness and physical activity (e.g. Choe et al., 2014; Fritz et al., 2014).

We adapted the wearable fitness tracker (Fitbit) for our study and thus, the Fitbit wristband became a monitoring technology that enabled the parents to track their children's physical activity and sleep, but it also enabled the children to self-track. Both the former and latter influenced how the children acted and behaved.

Boesen et al. (2014) studied location tracking in families and found that knowledge of location within families and the use of such knowledge are highly complex and cyclical. We observed similar aspects in our study and while we did not include direct location tracking, data on activity and sleep can also be interpreted and was often linked to location or whereabouts. For example, when a child was doing sports, parents assumed that this could be directly seen in the data. Therefore, some children optimized their data by walking longer walks with the dog or when going home from school.

CONCLUSION

We studied sleep and physical activity data of children and shared these data in their families to investigate how such data sharing influenced the relationship between children and their parents. We were particularly interested in seeing how this could affect parental trust. Our study presented insights into how parents interpret children's activity and sleep data and how this would trigger them to question their children. This led to increased parental control as they could control or verify children's responses to the collected data. However, it also reduced spontaneous and voluntary information disclosure from the children.

Our study suffers from a number of limitations. First, we interviewed the children while their parents were home at the same time. This was necessary for ethical reasons, but it could have influenced the children's answers even though the parents typically weren't directly present or in close proximity. Secondly, the relatively short duration of our study is another limitation in terms of how generalizable the results are. We clearly identified some novelty effects of the Fitbit technology. Finally, children (9-12 years) will clearly have an effect on the findings, because children

grow up and they become more independent. Therefore, older children might have exhibited different attitudes if being monitored by their parents. Future studies could consider age issues and differences for surveillance in families.

We discovered that our study clearly introduced new aspects of surveillance in the participating families, which should not be done without some ethical considerations. In this respect, it was important for us that the children were aware of what data was being collected, and that they had equal access to the data, and in fact used it as much as their parents throughout the study.

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