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**Increasing Physical Activity Levels in Children by Increasing Parents' Awareness of their Child's Physical Activity
A Feasibility Study**

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Increasing Physical Activity Levels in
Children by Increasing Parents'
Awareness of their Child's Physical
Activity: A Feasibility Study
by
MATTHEW HAYWARD

A Research Project Submitted in Partial
Fulfilment of the Requirements
for the Degree of
MSci (Hons) in Sport and Exercise Science
Department for Health

06/04/2019

Declaration

This project contains no material that has been accepted for publication for the award of any other degree or diploma at any institution. I certify that I have read and understood the entry in the Sport and Exercise Science student handbook on Cheating and Plagiarism and that all material in this assignment is my own work, except where I have indicated with appropriate references. The project does not contain experimental data from another person's work. The content of this project is the result of work that was carried out by me during my enrolment at the University of Bath. I agree that, in line with Regulation 15.3(e), if requested I will submit an electronic copy of this work for submission to a Plagiarism Detection Service for quality assurance purposes.

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Matthew Hayward

06/04/2019

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Abstract

Introduction: A considerable proportion of children do not meet recommended physical activity (PA) guidelines. Improving parents' awareness of their child's PA is a promising pathway to increase children's PA levels, and the feasibility of providing parents with multidimensional feedback of their child's PA in attempt to achieve this has not been tested. **Objectives:** 1) develop a method of providing multidimensional feedback to parents on their children's PA; 2) describe how parents respond to feedback of their child's PA; 3) investigate whether receiving feedback can impact children's short-term PA; and 4) establish parents' opinions on children wearing PA monitors. **Methods:** Parents (n=15) and their children (n=17) wore a Bodymedia Armband for seven days before feedback was delivered to parents in one-to-one audio-recorded interviews. Parents' responses to receiving feedback and their opinions on children wearing PA monitors were recorded, and later analysed using a thematic method of analysis. Changes in children's PA behaviours were reported by parents in a follow-up telephone call one month after receiving feedback. **Results:** Parents reported feedback as useful and motivating. Ten out of 13 parents reported improvements in their child's PA behaviours. Six out of 10 parents reported that they would prefer their child to receive sporadic multidimensional PA feedback, rather than wear a real-time PA monitor. **Conclusions:** Providing parents with sporadic personalised multidimensional feedback of their own and their child's PA could foster sustained engagement in PA for both adults and children. Further research is required to investigate the impact of this in more general populations.

Increasing Physical Activity Levels in Children by Increasing Parents' Awareness of their Child's Physical Activity: A Feasibility Study

Introduction

The benefits of regular physical activity (PA) for adults are well established and include reduced risk of type 2 diabetes and obesity (Hill & Peters, 1998; Hu et al., 2005), as well as greater well-being and reduced anxiety (Fox, 1999; Ströhle, 2009). Similar positive effects of PA in children are also well documented (Parfitt & Eston, 2005; Sibley & Etnier, 2003), but despite this, a 2015 health survey by the UK Government estimated that 77% of boys and 80% of girls aged 5-15 in England do not achieve the recommended 60 minutes of moderate-to-vigorous PA each day (Niblett, 2015). Compelling evidence exists to suggest that PA behaviours track from childhood into adulthood (Malina, 1996; Telama, 2009), and, therefore, increasing children's PA levels is essential for the future health of today's youth.

Child PA interventions

Interventions attempting to increase PA levels in young people have had varied degrees of success, with those in adolescents tending to report greater effects than those aimed at children (<12 years old) (Van Sluijs et al., 2007a). Child-focussed interventions have often been solely school-based and whilst some positive effects have been observed, there is little evidence of any influence on leisure time PA (Kriemler et al., 2011). Moreover, small sample sizes are commonplace (Van Sluijs, et al., 2007a), making type II errors (reporting of a false effect) likely (Dobbins et al., 2013), and self-report questionnaires are often used to assess PA (Taber et al.,

2009), leaving findings susceptible to recall bias (Prince et al., 2008).

Despite the general lack of high-quality child PA interventions, one successful strategy that has been identified is the involvement of family (Kipping et al., 2014; Van Sluijs, & McMinn, 2010). Parental support is well established as an important marker of child PA levels (Sallis et al., 2000; Trost et al., 2003), and research suggests that parents can positively influence their child's PA through placing value on PA, by modelling PA in their own behaviours, and by providing logistical support (e.g. taking children to activities and providing sports equipment). Moreover, intervention studies have confirmed the positive influence that parental involvement can have on child PA levels in both school (Kriemler et al., 2011) and home settings (Brown et al., 2016). Yet, while these findings demonstrate that family-based interventions provide a potential pathway to increase child PA levels, reported increases in PA have been inconsistent, and so, further research is required.

Increasing the awareness parents have of their child's PA

One potential barrier to parents supporting their child's PA is a lack of awareness of their child's PA (Bentley et al., 2012; Corder et al., 2010). Studies investigating the relationship between adults' perception of their own PA and their actual PA, have found that inactive individuals often overestimate their PA (Ronda et al., 2001; Van Sluijs et al., 2007b). A similar relationship was observed by Corder et al. (2010) between the awareness parents have of their child's PA and their child's actual PA levels. It was found that children of parents who were aware of their child's PA, were almost twice as likely to meet PA guidelines as children of parents who were not.

Moreover, parents of inactive children were found to overestimate their child's PA by a greater margin than inactive adults have overestimated their own PA in previous literature. The validity of results was improved by the use of accelerometers to measure PA in this study, whilst the use of a large and heterogeneous sample of 1892 children from 92 schools means widescale conclusions are appropriate.

Feedback provision to improve parents' awareness of their child's health

Behavioural feedback is a recognised and often successful technique for changing people's behaviours (Michie et al., 2009). However, recipients of feedback, do not always accept it, and sometimes respond with negative reactions such as anger, denial, or hopelessness (Brett and Atwater, 2001; Klugger & DeNisi, 1996; Smither et al., 2005). Such reactions can sometimes have harmful consequences, and this has been demonstrated by researchers attempting to provide feedback to parents on their child's weight status (Davison & Birch, 2001; Gillison et al., 2014). Greater parental concern for weight status without consequent action was found, by Davison and Birch (2001), to correlate with more negative self-evaluations in 5 year old girls, regardless of their original weight-status. Such findings highlight the potential risk of raising parents' awareness to information concerning their child's health, and demonstrate the importance of minimising negative reactions to such information. However, despite these risks, providing parents with personalised feedback of their child's PA has been suggested by previous authors as a potential intervention route for increasing child PA levels (Bentley et al., 2012; Corder et al., 2010). Personalised PA feedback has been shown to motivate people (Western et al., 2015), and if this

technique can be used to motivate parents to provide improved support for their child's PA, it could have a positive influence on children's PA (Troost et al., 2003).

Wearable PA monitors as facilitators for feedback provision

One method of PA feedback that is becoming increasingly popular is that of real-time feedback from wearable PA monitors (Fritz et al., 2014; Piwek et al., 2016). Commercially available PA monitors (e.g. Fitbit, Garmin), are often designed with a display screen, allowing users to constantly monitor different aspects of their health-related behaviours. However, such technology is often poorly adhered to in adult populations (Ledger & McCaffrey, 2014), and preliminary evidence suggests that sustained engagement is also poor in children (Schaefer et al., 2016).

In a recent review, Ridgers et al. (2016a) suggested that wearable PA monitors could be an effective tool for increasing PA levels in young people. However, limited intervention effects were observed, which was likely due to their analyses only including three intervention studies, of which two were statistically underpowered due to small sample sizes. Only one randomised control trial has investigated the influence of wearable PA monitors on youth PA behaviours. Slootmaker et al. (2010) observed short-term increases (3 month follow-up) in moderate levels of PA among adolescent girls, and long-term reductions (8 month follow-up) in sedentary time among adolescent boys. Participants were given unrestricted access to a web-based, tailored PA advice program, which was coupled with accelerometers worn by participants for 24 hours a day. As such, these findings suggest that PA monitors without real-time feedback have the potential to increase

young people's PA. It should, however, be considered that 90% of boys and 67% of girls in this study were already meeting the recommended PA guidelines upon recruitment, and thus, effects may have been different in a less active population.

Motivational impacts of real-time PA monitors

For adults, recent research has suggested that wearable PA monitors should be used to support changes in PA by providing frequent real-time feedback (Patel et al., 2015). However, this does not appear to be the case for young people (Schaefer et al., 2016; Kerner & Goodyear, 2017). In their study investigating the motivational impact of wearing a Fitbit for eight weeks on 84 adolescents (44 girls, 40 boys), Kerner and Goodyear (2017) noticed significant reductions in need satisfaction and autonomous motivation, as well as significant increases in amotivation. Autonomous motivation is enabled via the fulfilment of three basic psychological needs: autonomy (feeling that one can act out of their own volition); competence (feeling that one can be proficient and effective); and relatedness (feeling valued by peers) (Ryan & Deci, 2000a). Social contexts that do not support these needs can cause reduced well-being (Ryan & Deci, 2017), and therefore, findings by Kerner and Goodyear (2017) suggest that real-time PA monitors could have harmful impacts on adolescent users.

Furthermore, in a six month feasibility study of using a Fitbit PA monitor to increase PA in 11-to 12-year-old children (n=34), Schaefer et al. (2016) observed low sustained engagement, and suggested this was partly due to the quality of motivation that was instilled. High levels of PA were recorded in the first few days of monitoring, before activity levels reduced dramatically. This initial spike in PA was

suggested to be due to reactivity, a phenomenon wherein individuals alter their PA because they are aware of being observed (Mace & Kratochwill, 1985). Such behaviours are indicative of externally regulated forms of motivation, and behaviours adopted for these reasons are unlikely to be sustained (Deci & Ryan, 2008).

Child focused personalised multidimensional PA feedback

Over the last decade novel forms of PA monitors have been developed, allowing the accurate measurement of multiple aspects of an individual's PA (Thompson & Batterham, 2013). Multidimensional feedback from such devices can decrease the likelihood that people will form erroneous conclusions about their PA, as several aspects of an individual's PA can be reviewed (Thompson et al., 2015). It has been shown that adults can accurately interpret multidimensional feedback of their own PA (Western et al., 2015), and therefore it seems likely that parents could accurately interpret similar feedback of their child's PA. Such feedback would raise the awareness parents have of their child's PA, but alongside this lies the potential to raise the awareness parents have of their own PA, too. Providing tailored feedback to parents, together with feedback for their child, could not only influence their own PA (Western et al., 2015), but parents modelling changes in their own PA could also invoke changes in their child's PA behaviours (Sallis et al., 2000; Trost et al., 2003).

In their study providing one-off personalised multidimensional PA feedback to individuals at risk of chronic disease, Western et al. (2015) observed that feedback was motivating for patients. Patients reported that feedback was useful for directing their efforts to become more physically active, with many suggesting that they could

independently use it to effectively self-monitor their PA and to set appropriate goals. Multiple theoretical frameworks endorse the use of self-monitoring and goal-setting for sustained changes in health-related behaviours (Greaves et al., 2011; Michie et al., 2009) and consequently, such practice seems an ideal tool for providing feedback to parents on their child's PA. Not only could this approach potentially raise parents' awareness to areas in which their child's PA is deficient, it could also provide them with the appropriate motivation to direct their supportive behaviours effectively.

Improving the awareness parents have of their child's PA presents a promising pathway to increase children's PA levels, and with the development of new technology for monitoring PA, researchers now have the means to do this. However, before any intervention study to establish the effects that providing parents with personalised multidimensional feedback on their child's PA can have, the feasibility of this approach must first be tested. Therefore, the present study has the following objectives: 1) to develop a method to provide feedback to parents on their children's PA by adapting the multidimensional approach used in previous work with adults; 2) to describe how parents respond to one-off personalised multidimensional feedback of their child's PA; 3) to investigate whether receiving feedback of their child's PA in this manner can impact their child's short-term PA levels, as reported by parents; and 4) to establish parents' opinions on children wearing PA monitors.

Methods

The study was approved by the Department of Health Ethics Committee at the University of Bath and written, informed consent was obtained from all parents.

Written, informed assent was also obtained from all children (see both assent and consent forms in Appendix A).

Study design

To explore and better understand how parents responded to feedback of their child's PA, and to understand parents' opinions on children wearing PA monitors, qualitative approaches were used. However, to establish the manner of any changes in behaviour which occurred, quantitative methods were implemented. As such, a mixed methods design was adopted (Johnson & Onwuegbuzie, 2004), originating from a pragmatic research outlook, which was guided by the research question without allegiance to any specific epistemological standpoint.

Procedure

Design of multidimensional feedback

Feedback was presented to parents in the form of infographics which were developed from previous work by Western et al. (2015). Although infographics were only to be interpreted by the parents in interview, the intention was for them also to be child friendly, so colourful and bold formatting was used (Boyatzis & Varghese, 1994). PA information was provided in three sections: activity patterns for each day of the week; distinct aspects of PA in comparison to multidimensional health targets (Thompson & Batterham, 2013); and sleep patterns for each night of the week. Paper copies of infographics displaying this information were created for each parent and child (an example is shown in Appendix B) and shown to parents in interviews.

Following the work of Thompson and Batterham (2013), times spent in distinct intensity thresholds, as well as multidimensional health target attainments, were calculated based on metabolic equivalent cut-off points (METs). Universal cut-off points were colour coded based on intensity (see Appendix B), and the same intensity thresholds were used for both parents and children (Thompson & Batterham, 2013). Multidimensional health targets followed a traffic lights system so that participants were shown as meeting the target (green), close to the target (amber), or below the target (red). For adults, the same thresholds were set for multidimensional health targets as have been used in previous work (Thompson & Batterham, 2013), while for children adjusted thresholds were used for both Steps (green = ≥ 14000 steps/day, amber = 14000-10000 steps/day, red < 10000) and Sleep (green = ≥ 9 hours/night, amber 7-9 hours/night, red = < 7 hours/night). New thresholds for children were based on the guidelines set by the UK government (Niblett, 2015). The same thresholds as adults were used for both children's Sedentary time and their Active minutes. Each minute of missing data was assigned that individual's basal metabolic rate (equivalent to one MET).

Recruitment

Parents and their six- to eleven-year-old children were recruited from two areas in the UK (Bath and North East Somerset, and South Somerset). The recruitment process took place via four methods: 1) emails describing the study were sent to parents of children who attended either athletics or trampolining clubs at the University of Bath; 2) posters were put up around the University of Bath Sports

Training Village; 3) parents were spoken to while their children practiced athletics or trampolining; and 4) parents known by the lead researcher (MH) were contacted. Once parents had verbally agreed to take part, they and their child(ren) met with the lead researcher and were given the chance to ask questions. Parents and children were able to take part if they had no condition which could impair their PA during the data collection period, and they did not swim or play heavy contact sports more than three times per week (this would limit the accuracy of data as PA monitors could not be worn for such activities). In total, 17 parents and 19 children were recruited for the study (in two cases two siblings decided to take part together).

Collection of PA data

Parents and children were each given an arm-mounted Bodymedia Armband (SenseWear Pro 8.0, Pittsburgh, USA) which accurately estimates energy expenditure in adults (Lee et al., 2014) and children (Lee et al., 2016). They were asked to wear the device for seven consecutive days (measured from midnight to midnight), and were instructed to remove it only for showering, water-based activities or for heavy contact sports (Ridgers et al., 2016b). Participants were excluded if data were collected for less than 70% of the seven day period.

One-to-one feedback interviews with parents

Feedback was delivered to parents by the lead researcher in audio-recorded one-to-one interviews, which were each conducted within two to three weeks of the PA data collection period. A semi-structured interview guide was followed (see Appendix C) that included questions to capture: parents' opinions on what it was like wearing

the armbands (before feedback delivery); their responses to receiving personalised multidimensional feedback of their own and their child's PA behaviours; and the potential practical consequences of receiving feedback in terms of its motivational influence. Discussion of each section of the infographics was preceded by a brief verbal explanation. During this stage the lead researcher was careful not to interpret the feedback, instead only explaining to parents how to interpret its content. Feedback of the parent's PA was initially delivered, followed by feedback of the child's PA, once it was deemed that all aspects of their own feedback had been discussed. Activity patterns for each day of the week were discussed first in every interview, to allow parents to identify activities that they knew either they or their child did. After discussion of the feedback, five parents answered questions of the impact that they believe PA monitoring has on children. Such questions were not part of any structured interview guide (for examples of question framing, see Appendix D).

Follow-up interviews

Between three and five weeks after receiving PA feedback, 12 parents were interviewed in audio-recorded telephone calls, during which it was discussed whether, and if so how, the feedback they had previously received had influenced their own and their child's PA behaviours (see Appendix E for interview guide). After discussing this, questions surrounding the impact that they believe PA monitoring has on children were asked to five parents who had not previously discussed the topic in their initial interview. Such questions were, again, not part of a structured interview guide (see Appendix D). One parent responded to questions via email.

Methods of analysis

Thematic analyses

Audio recordings of one-to-one feedback interviews were transcribed verbatim, as were the five telephone interviews in which parents' opinions on children wearing PA monitors were discussed. Interview recordings were analysed using an inductive thematic approach, as per the methods outlined by Braun and Clarke (2006). Transcripts were read by the lead researcher before codes were produced to capture features of the data that were meaningful and relevant to the research question. Codes were subsequently grouped to create a number of lower level themes placed within two salient overarching themes. Lower level themes were refined until deemed as distinct as possible, whilst still being representative of their content. A model was also developed, to encapsulate the process parents went through when responding to feedback in one-to-one interviews (see Figure 1).

Content analysis

Telephone interviews and the one email were analysed via a summative approach to quantitative content analysis (Hsieh & Shannon, 2005). A deductive method was adopted, as face-to-face interviews were initially analysed for content that eluded to the aspects of their child's PA that parents wanted to change. Audio recordings were subsequently listened to, to identify the aspects of each child's PA that: had been changed; had not changed; or were still intended to be changed. Data were analysed in this way so that the different aspects of children's PA that were influenced by receiving feedback could be quantified.

Results

Participants

Of the children that agreed to participate, two did not provide PA data for more than 70% of the time they spent wearing the armband and so withdrew from the study along with their parents. One-to-one interviews were conducted with all 15 remaining parents (14 of whom were from the Bath and North East Somerset area). Participant characteristics in are displayed in Table 1.

Table 1: Characteristics of participants

Characteristic	Parents (n = 15)		Children (n = 17)	
	Mean	Range	Mean	Range
Age	41	31 – 55	9	7 – 11
Weight (kg)	71.0	47.2 – 121.7	32.8	24.0 – 46.9
Height (m)	1.69	1.60 – 1.83	1.38	1.24 – 1.61
Sex	N	%	N	%
Male	3	20	11	65
Female	12	80	6	35

Child PA behaviours

All 17 children were classified as not meeting at least one multidimensional health target, while 15 children were also classified as being close to a target in at least one other aspect of their PA feedback. The multidimensional health target which children performed worst in was Sedentary time, with no children meeting this target. In contrast, the multidimensional health target which children performed best in was their Active minutes, with eight children meeting this target. Thirteen children were classed as close to the target for Sleep, while Step count was the most variable parameter, with averages ranging from 8311 to 18025 steps per day.

Parents' responses to multidimensional feedback of their child's PA

When provided with feedback of their child's daily activity patterns most parents recognised several activities which their child did (e.g., *"Yeah, it's interesting...they both go to football practice, they both go to hockey practice...and they both walk to school and back every day"*). However, some were surprised by the intensity of their child's activities, often suggesting that they expected them to be working harder (e.g., *"I'm surprised she hasn't got more amber [vigorous activity] and red [very vigorous activity]"*). Upon receiving feedback of their child's PA in relation to multidimensional health targets, parents tended to focus on the negative aspects of the feedback initially. This was often demonstrated by their surprise at the amount of time their child spent sedentary (e.g., *"look at the 11 hours sedentary...he's not that far behind me, which does surprise me in a way"*).

The time parents took to suggest that they had accepted most aspects of the feedback, varied considerably between participants. Some did not question the truth of the feedback and quickly identified what they perceived as the positive and negative aspects of their child's PA behaviours (e.g., *"I'm really happy he's green for most of it... but he does need to stop sitting down quite as much"*). While others took longer to get to this stage, often going in cycles between questioning feedback and suggesting that they believed the information it contained (e.g., *"Yeah but in the mornings if you look, there's not much going on then, but I know he often goes on the trampoline and cycles to school...but maybe it's just picking up as blue [moderate activity]"*). A visual depiction of this process is shown in the left side of Figure 1.

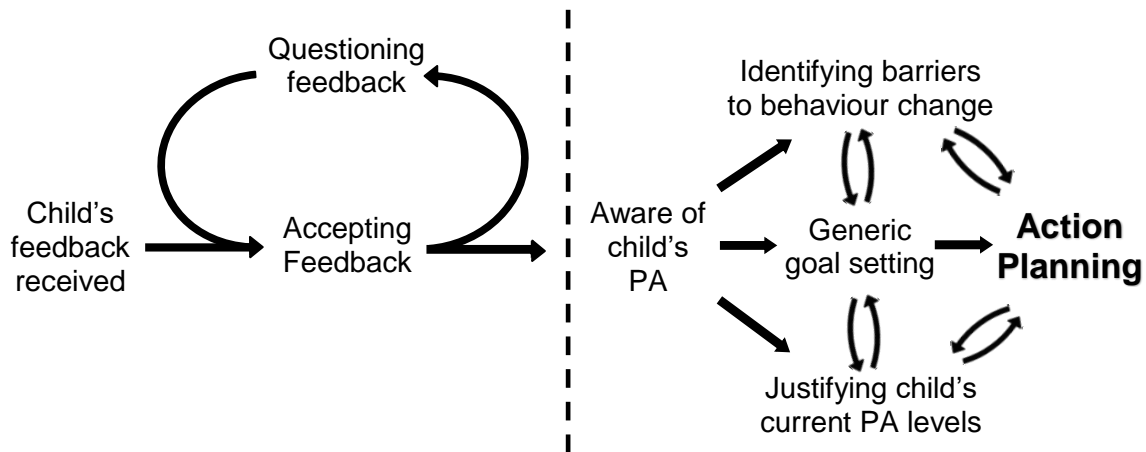


Figure 1: A two stage model of the process parents go through after receiving multidimensional feedback of their child's PA.

Parents' responses, once they had interpreted their child's feedback, took three forms (see the right side of Figure 1). Some were able to recognise aspects of their child's PA that they thought should improve (e.g., *"now they do come home, and we have an X-box and they have an iPad...so there's a lot of Fortnite playing going on..."*), others focussed on giving reasons for why their child was inactive in certain regards (e.g., *"It's better in the summer obviously, I mean this is ridiculous, but in the summer, we'd go up the park after dinner, but in the winter we just sit at home"*), while some identified the difficulties they could face in making any changes in behaviour (e.g., *"It's very hard to get kids to do active things after school, I mean there's after school clubs but..."*). Parents often gave responses akin to more than one of these examples, while some parents were able to move on from these discussions to suggest how they could support their children in making changes to their PA (e.g., *"I was wondering if rather than running at the beginning of the day, I should instead be running at the end of the day with my daughter"*). This was not always the case though, and some made vague statements about what they might

do (e.g., “we’ll probably go through what he’s actually doing...he needs to push himself a little more”), while others suggested that it would be difficult to achieve the goals they had previously set (e.g., “I know he should improve it, but the sedentariness is really hard, what do you do? We haven’t got a big garden...”).

Changes in child PA behaviours

Of the 15 parents that were interviewed face-to-face, 13 were asked questions about how their child’s PA had been influenced by receiving feedback. All 13 parents had identified at least one aspect of their child’s PA which they wanted them to improve in their initial interview. Ten parents reported their child(ren) achieving some form of change in at least one aspect of their PA, with one other parent suggesting that despite their child not yet making changes in any aspect of their PA, they still intended to. Reported changes in children’s behaviours and parents’ intentions one month after receiving the feedback can be seen in Table 2.

Parents’ opinions on children wearing PA monitors

During face-to-face interviews five parents gave their opinions on children wearing PA monitors, while another five discussed the same topic during telephone interview. Of these ten parents, nine suggested that some form of PA monitoring is beneficial and fun for children. Three parents stated that real-time PA monitors were a good tool for measuring children’s PA, with all of these parents stating that they would rather their child wear a real-time PA monitor than receive sporadic feedback on their PA. In contrast, seven parents suggested that PA monitors could be harmful for children, with six of these voicing that they would rather their children receive

sporadic feedback on their PA rather than wear a real-time PA monitor. Two parents suggested that children who are already active do not need to monitor their PA at all. All parents stated that they had found feedback useful, with most saying that it had raised their awareness of their child's PA. Example quotations displaying evidence of all of the above statements can be seen in Appendix F.

Table 2: Changes in different aspects of children's PA, as reported by parents (n=13) one month after receiving multidimensional feedback of their child's PA

Aspect of PA	Initial interview		Telephone interview		Examples of successful changes in child PA
	Expressed intent to change in	Achieved change	No change yet but intend to	No change & do not intend to	
Steps	4	2		2	<ul style="list-style-type: none"> Walk to school rather than drive
Active Minutes	6	3	2	1	<ul style="list-style-type: none"> Cycle to school with mum Uses a new dance based video game, often with parents
Sedentary Time	8	6	1	1	<ul style="list-style-type: none"> Family walks/ cycle rides Joined a new sports clubs Started using Pokémon go Time restrictions for video games
Sleep	3	1	1	1	<ul style="list-style-type: none"> Earlier bed times

Note - parents that expressed intent to change multiple aspects of their child's PA are included in multiple rows. Two parents expressed no intent to change any aspect of their child's PA.

Discussion

The purpose of the present study was to test the feasibility of providing parents with one-off multidimensional feedback of their child's PA as a method to increase

children's PA levels. It was found that parents tended to be accepting of this feedback and often, after receiving it, suggested ways in which their child could make positive changes to their PA behaviours. Moreover, one month after receiving feedback 10 out of 13 parents reported improvements in their child's PA behaviours. Parents' opinions on children wearing PA monitors were also obtained, with six out of 10 parents reporting that they would prefer their child to receive sporadic personalised PA feedback, rather than wear a real-time PA monitor.

Parents accepted and were motivated by feedback of their child's PA

Previous work providing feedback to parents on their child's weight status has had limited success (Davison & Birch, 2001; Gillison et al., 2014), and despite efforts to provide feedback in a sensitive manner, negative reactions have still tended to be observed (Grimmett et al., 2008). This was suggested by Gillison et al. (2014) to be partly due to feedback being interpreted by parents as 'telling' them what to do. To reduce the likelihood of this occurring in the present study parents were encouraged to interpret feedback without assistance from the lead researcher. This meant that information was delivered in a manner which did not dictate parents' actions, and in line with previous findings in adults (Western et al., 2015), was found to facilitate parents' sense of volition. Despite often cycling between questioning the validity of feedback and suggesting that they believed the information it contained, few parents in the present study responded negatively to feedback of their child's PA, and any uncertainty was usually resolved after discussion with the lead researcher.

Once parents had interpreted feedback of their child's PA some responded by either giving reasons why their child was inactive, or by identifying the barriers they perceived to be in the way of changing their behaviours (Figure 1). Gillison et al. (2014) observed similar responses when providing feedback to parents on their child's weights status. They suggested resistance to feedback could result from parents feeling obliged to act, something which they often feel uncomfortable with, or do not believe they can do. Authors also proposed that these manner of responses represented a manifestation of cognitive dissonance – defined as, the uneasiness felt by an individual when they feel there is a mismatch between their beliefs and their actions (Festinger, 1962). This was likely experienced by parents in the present study and is evidenced by the surprise which parents often expressed upon receiving feedback of their child's PA. Feelings of cognitive dissonance can be dealt with by either changing one's behaviours or changing one's beliefs, and responses of denial are common when faced with these feelings (Gosling et al., 2006). However, in the present study, denial of feedback was not commonplace, and it is proposed that this was facilitated by the initial focus during interviews on parents' own daily activity patterns. This process allowed parents the opportunity to recognise activities which they knew they did, before having the same opportunity when interpreting their child's PA. This consequently made it difficult for them to justify any suggestions that either their own or their child's PA had not been measured correctly.

After interpreting feedback many parents went on to start creating action plans for how they could support their child in doing more PA. To facilitate action

planning, immediately after parents had suggested that an aspect of their child's PA could be improved they were often asked about how they thought their child could do this (see Appendix C). This proved to be an effective technique and is in line with methods endorsed by the practice of Motivational Interviewing (MI). MI is a client-centred approach for enhancing intrinsic motivation (a person's internal desire to act, for the sake of their own fulfilment) to change, and suggests that individuals should direct their own behaviour change strategies with help from professionals, rather than the other way around (Miller and Rollnick, 2002). By asking parents how they thought they could act, this provided freedom of choice, and so conformed with MI techniques found to work in similar health promotion settings (Rollnick et al., 2002).

Successful changes in children's PA behaviours

One month after receiving one-off personalised feedback of their child's PA, 10 out of 13 parents reported that their child had changed their PA behaviours in some manner. No previous study has delivered one-off personalised feedback of children's PA to parents, and as such, these findings are the first to provide evidence that feedback delivered in this style could increase children's PA levels. Changes in children's PA behaviours were likely influenced by both increased support from parents for their PA (Sallis et al., 2000; Trost et al., 2003), and children interpreting feedback themselves (Lau et al., 2011). To facilitate the likelihood that both parents' support of their child's PA and children's perspective of their own PA were influenced by viewing feedback, colourful and bold designs were used. Furthermore, to support sustained changes in parental support, established behaviour change techniques of

goal-setting and barrier identification were used during face-to-face interviews, in addition to the formerly discussed technique of action planning (Michie et al., 2009).

Findings from the present study were also able to provide evidence of how different aspects of children's PA were influenced by receiving one-off personalised multidimensional PA feedback. Sedentary time and Active minutes were the two aspects of children's PA which parents most frequently expressed the desire to change in face-to-face interviews, with six out of eight, and three out of six parents, respectively, reporting in follow-up interviews that their child had managed to achieve this. Behaviours which children were reported to adopt often encompassed both reductions in Sedentary time and increases in Active minutes, with many parents reporting the uptake of family-based activities (see Table 2). This finding suggests that the manner in which feedback was delivered encouraged children and parents to start being more physically active together. Previous work has shown that encouraging families to spend time physically active together is a successful intervention strategy (Brown et al., 2016), and as such, our findings suggest that one-off personalised multidimensional PA feedback could be used for this purpose.

Some Parents would prefer their child not to wear a real-time PA monitor

Nine of the 10 parents in the present study, who gave their opinions on children wearing PA monitors said that they believed some form of PA monitoring is good for children. Three parents said that they believed real-time monitors were good for children, suggesting that they can motivate them to be physically active by providing rewards and allowing them to set goals. While this may be true in the short term

(Hayes & Van Camp, 2015), recent research found that children who wore real-time PA monitors for six months did not achieve sustained increases in their PA levels (Schaefer et al., 2016). Consequently, future research is needed to confirm whether or not real-time PA monitors can cause sustained changes in children's PA levels.

In the present study, seven out of 10 parents said that they thought wearing a real-time PA monitor could be harmful for their child, often citing the belief that children can become obsessed with them to support this. These opinions are supported by evidence that real-time PA monitors can invoke maladaptive forms of motivation for both children (Schaefer et al., 2016) and adolescents (Kerner & Goodyear, 2017). Some parents also suggested that real-time PA monitors can put too much pressure on children by constantly reminding them of a 'score' of their PA. In their study investigating whether wearing a Fitbit for eight weeks impacted adolescents' motivation for PA, Kerner and Goodyear (2017) found that Fitbits put pressure on participants through both external (achievement of rewards) and internal means (guilt and social approval). When an individual adopts a behaviour because of the perceived possibility of external reward, or for reasons of guilt or social approval, engagement is unlikely to be maintained and impoverishment of well-being can occur (Deci & Ryan, 2008). Our findings suggest that some parents are aware of the potentially harmful effects of real-time PA monitors, and can therefore act to educate their children on these matters. However, others are not, and with the emerging popularity of devices like Fitbits there is need for evidence to enlighten the general public of the potential impacts of such devices on young people's health.

Parents liked receiving one-off feedback of their child's PA

Although seven parents in the present study suggested that they would prefer their child not to wear a real-time PA monitor, six of them said that they would be happy for their child to wear the PA monitor used in our intervention instead. One of the most cited reasons for this was that the monitor did not have a real-time display, whilst some parents also liked the monitor being positioned 'out of the way' on the upper arm. Some parents also said that they would like to receive personalised multidimensional feedback of their child's PA on a sporadic basis, with one parent suggesting that a six-monthly review could be an appropriate time frame for this.

Limitations

The main limitation of the present study is the poor generalisability of findings. All but one family recruited for the study were from the Bath and North East Somerset area, so it is unlikely that this sample were representative of the wider population. Furthermore, most children in the study attended sports clubs at the University of Bath. As such, it seems probable that most parents already had an interest in their child's PA, and would therefore have been more be receptive to feedback than other parents who place less value on the importance for their child to be active.

Furthermore, as follow-up interviews were only conducted one month after providing feedback, this study can only provide evidence suggesting that children's PA was influenced in the short term. It is possible that some behavioural changes were maintained, however, no evidence is provided to support this. Moreover, changes in children's PA behaviours were reported by parents, a method which is

often unreliable by nature (Corder et al., 2010). In their study investigating parents' perceptions of their child's PA, Corder et al. (2010) reported that 80% of parents with inactive children overestimated their child's PA, and as such, it is possible that overestimation bias also occurred in our study. Finally, it is difficult to interpret the effect that the present intervention had on PA levels. Although 10 out of 13 parents reported their child adopting new PA behaviours, this could have replaced PA behaviours which were already in place, and thus, overall PA may not have changed.

Conclusions

In the present study, few parents expressed negative reactions to personalised one-off multidimensional feedback of their child's PA, and the majority of parents reported that their child had improved some aspects of their PA one month after receiving feedback. Furthermore, some parents suggested that they would find it useful to receive sporadic personalised multidimensional feedback of their own and their child's PA. If parents were to be provided with this, sustained engagement in PA could be fostered for both adults and children, while such a practice could be a cost effective technique for facilitating increases in PA levels, as PA would not need to be monitored over extended periods. As such, further research is required to investigate the impact of providing parents in more general populations with sporadic personalised multidimensional feedback of their own and their child's PA.

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Appendix

A. i) Parent Information Sheet/Consent Form



DEPARTMENT FOR HEALTH SPORT AND EXERCISE SCIENCE

Name of Researcher: Matthew Hayward

Contact details of Researcher: mh887@bath.ac.uk
07887392520

Name of Supervisor: Fiona Gillison

Contact details of Supervisor: f.b.gillison@bath.ac.uk
01225 384387

Research Project Title:

What do parents make of feedback on the multidimensional physical activity of their child?

Purpose of Study:

We know some parents are interested to find out more about how much physical activity, and how much sedentary time (i.e., such as on the computer or watching television) their children should be getting for their health. But not knowing what goes on in schools, or how to work out how much is enough can make this difficult.

In this study we want to test out a new way of providing feedback using an accelerometer (a bit like a fitbit), that means we can give you accurate feedback on different aspects of your child's activity – from light, moderate

and vigorous activity, to the number of steps and time spent sedentary. We would like to find out if parents find this interesting, useful, and how they might respond to this feedback.

Description of Procedures:

Once you have consented to participation we will provide you with an arm-mounted physical activity monitor which your child will be asked to wear for seven consecutive days. It will be requested that this device is only removed for water-based activities or in activities where heavy physical contact is expected (e.g. rugby). It will be requested that your child lives as ‘normal’ a life as possible for this period (in other words imagine they were not wearing the device and act as they otherwise would). After one week of data collection is complete your child can remove the device and we ask that the device is returned.

Within 2 weeks of collecting physical activity data, clear graphics of your child’s physical activity data will be created. We will arrange a time convenient to you to talk through the feedback and ask you some questions around what you think about it. This should take no longer than half an hour, and we will give you a print out of the feedback to take away. With your consent, we will record the discussion so we can remember what is said, but we will type this out and remove any names or places to make sure it is anonymous before we do any analysis, and will delete the recording as soon as this is done. We ask that your child is not present for this discussion.

About four weeks after we have given you your child’s feedback we will follow up with a brief phone call to ask if anything has changed for you since getting the feedback.

Inclusion criteria:

Parents

- You are happy to receive feedback of your child’s physical activity in a recorded interview

Child

- Aged between 6 and 11 years old
- Has no medical condition or injury which affects their ability to be physically active during the week after you sign up

- Does not swim or play rugby more than 3 times per week (if they do, the bands have to be removed, which limits the data we can obtain)

Potential risk to volunteers:

The associated risks of this study are almost null. Activity monitoring devices are safe to wear and do not pose any danger to participants, unless worn when playing heavy contact sports (e.g. rugby). Children are asked to remove the device in this case.

Potential pain and discomfort to volunteers:

Physical activity armbands should not be uncomfortable to wear but contact details will be provided in the case that there are any issues with wearing the device.

Benefits to volunteers:

You will receive a full report of their child's physical activity levels allowing you to understand the areas where your child is physically active enough and areas where they may need to do more.

You will be supporting novel research into the potential use for feedback of child physical activity levels as a method to improve the support parents provide for their child's physical activity.

Receiving specific tailored feedback of your child's physical activity will also likely help improve your understanding of physical activity as a concept.

Statement of confidentiality:

Confidentiality of personal information will be ensured. Raw data sheets will be destroyed upon study completion whilst audiotaped interviews will be deleted once analysed. Electronic data files will be stored on a secure server and may be archived by the University for up to 10 years. All data will be only accessible by the lead researcher and the two other researchers involved in the project (Dr Fiona Gillison and Dr Oliver Peacock). Participants (parents or child) are free to withdraw from the study at any point that they please, however, data will be anonymized after the final telephone interview and thus withdrawal will not be possible within a week of this date.

Participant Declaration:

I fully understand what taking part in this study involves. Any questions I have about the study, or my participation in it, have been answered to my satisfaction. I have been informed that I am free to withdraw my consent and discontinue participation at any time. If I decide to withdraw I understand that it will not have any undesirable consequences. I have had my attention drawn to the following guidelines for research involving human subjects:

- a) A general statement of the background of the project and its objectives
- b) An explanation of procedures, identifying any experimental ones and describing any inherent risks/ discomfort
- c) A description of any benefits which might be expected
- d) For questionnaires or interviews, an instruction to the effect that the participant is free to refuse to respond to any specific item or question
- e) An explanation of the procedures to be used to ensure the confidentiality of all data and information to be derived from the participant. If participants are to be identified by name in any manuscript, then permission for this must be included in the informed consent form.
- f) A disclosure relating to any photography, videotaping, or audiotaping of the participant. In addition, a statement must be attached indicating who is to have custody of such material, who is to have access to it, how the material is to be used, and what is to be done with the material when the study is completed.

It has been made clear to me that, should I feel that these regulations are being infringed or that my interests are otherwise being ignored, neglected, or denied, I should inform the BSc Sport and Exercise Science Director of Undergraduate Studies (Dr Ezio Preatoni, 01225 383959, E.Preatoni@bath.ac.uk), who will investigate my complaint.

Print name: _____

Signature _____

Date: _____

Researcher name: _____

Signature _____

Date: _____

ii) Child Information Sheet/Assent Form



DEPARTMENT FOR HEALTH
SPORT AND EXERCISE SCIENCE

Name of Researcher: Matthew Hayward

Contact details of Researcher: mh887@bath.ac.uk
07887392520

Name of Supervisor: Fiona Gillison

Contact details of Supervisor: f.b.gillison@bath.ac.uk
01225 384387

Research Project Title:

What do parents make of feedback on the multidimensional physical activity of their child?

Why is this research happening?

For children to be healthy it is important that they do plenty of physical activity. We want to measure how much physical activity you do and then to use this information to help parents like yours provide the best support possible to children like you.

What would I have to do?

You will be asked to wear a physical activity monitoring armband for 7 days in a row. We do not want you to do anything different to normal during these 7 days (imagine you are not wearing the device and act as you normally

would). We ask that you wear the monitor as much as possible (even when sleeping) and only take the monitor off for water activities like showering or swimming. We also ask that you remove the device if you are playing full contact rugby.

How do I know if I can take part?

You can take part in this study if:

- You are aged between 6 and 11 years old.
- You have no medical condition or injury which affects your ability to be physically active during the 7 days when wearing the monitor.
- You do not swim or play rugby more than 3 times per week.

Do I have to take part?

Absolutely not! Taking part in this study is entirely your choice and you are free to stop at any point. We would be very grateful if you did manage to complete the study but if you decide at any point that it isn't for you then that is completely fine, please just let us know and return the armband.

Are there any risks for me?

Taking part in this study will add virtually no risk further risk to you. The only potential risk of being injured is if you wear the monitor during heavy contact sports. This is why we ask that you remove the monitor for playing sports like Rugby. If you are unsure whether it is safe to wear the monitor for an activity, ask your teacher or parent and they will tell you what is best to do.

Are there any benefits for me?

A few weeks after you have worn the monitor your parents will be given a booklet which tells you how active you are. This will explain what areas you are doing well in and others where you could improve.

Will my information be kept private?

Your personal information will only be seen by the researchers involved in the project (Matthew Hayward, Dr Fiona Gillison and Dr Oliver Peacock). When the study is written we will not use your name or any information that would let others know who you are.

Participant Declaration:

I fully understand what is going to happen if I take part in this study.

All of my questions about the study, and what I will have to do, have been answered.

I have been told that I can stop the study at any time.

I understand that nothing bad will happen if I decide to drop out.

Print name: _____

Signature _____ Date: _____

As a parent/guardian of a study participant, I have been told about the following guidelines for research involving human subjects:

- a) A general statement of the background of the project and its objectives
- b) An explanation of procedures, identifying any experimental ones and describing any inherent risks/ discomfort
- c) A description of any benefits which might be expected
- d) For questionnaires or interviews, an instruction to the effect that the participant is free to refuse to respond to any specific item or question
- e) An explanation of the procedures to be used to ensure the confidentiality of all data and information to be derived from the participant. If participants are to be identified by name in any manuscript, then permission for this must be included in the informed consent form.
- f) A disclosure relating to any photography, videotaping, or audiotaping of the participant. In addition, a statement must be

attached indicating who is to have custody of such material, who is to have access to it, how the material is to be used, and what is to be done with the material when the study is completed.

- It has been made clear to me that, should I feel that these regulations are being infringed or that the participant's interests are otherwise being ignored, neglected, or denied, I should inform the BSc Sport and Exercise Science Director of Undergraduate Studies (Dr Ezio Preatoni, E.Preatoni@bath.ac.uk, 01225 383959), who will investigate my complaint.

As the participant is under 18 years of age, a parent/ guardian signature is required.

Parent/Guardian name: _____

Signature _____

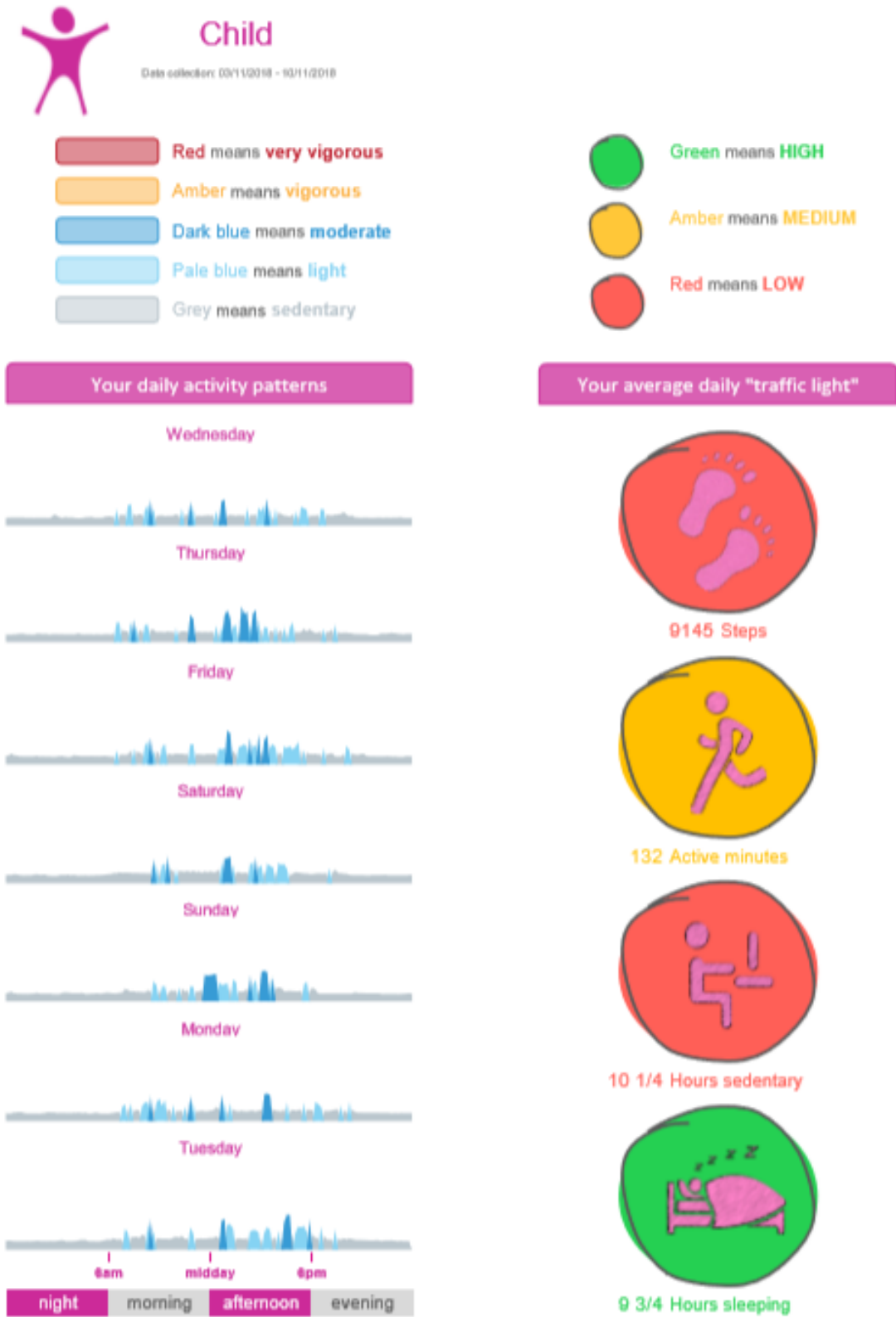
Date: _____

Researcher name: _____

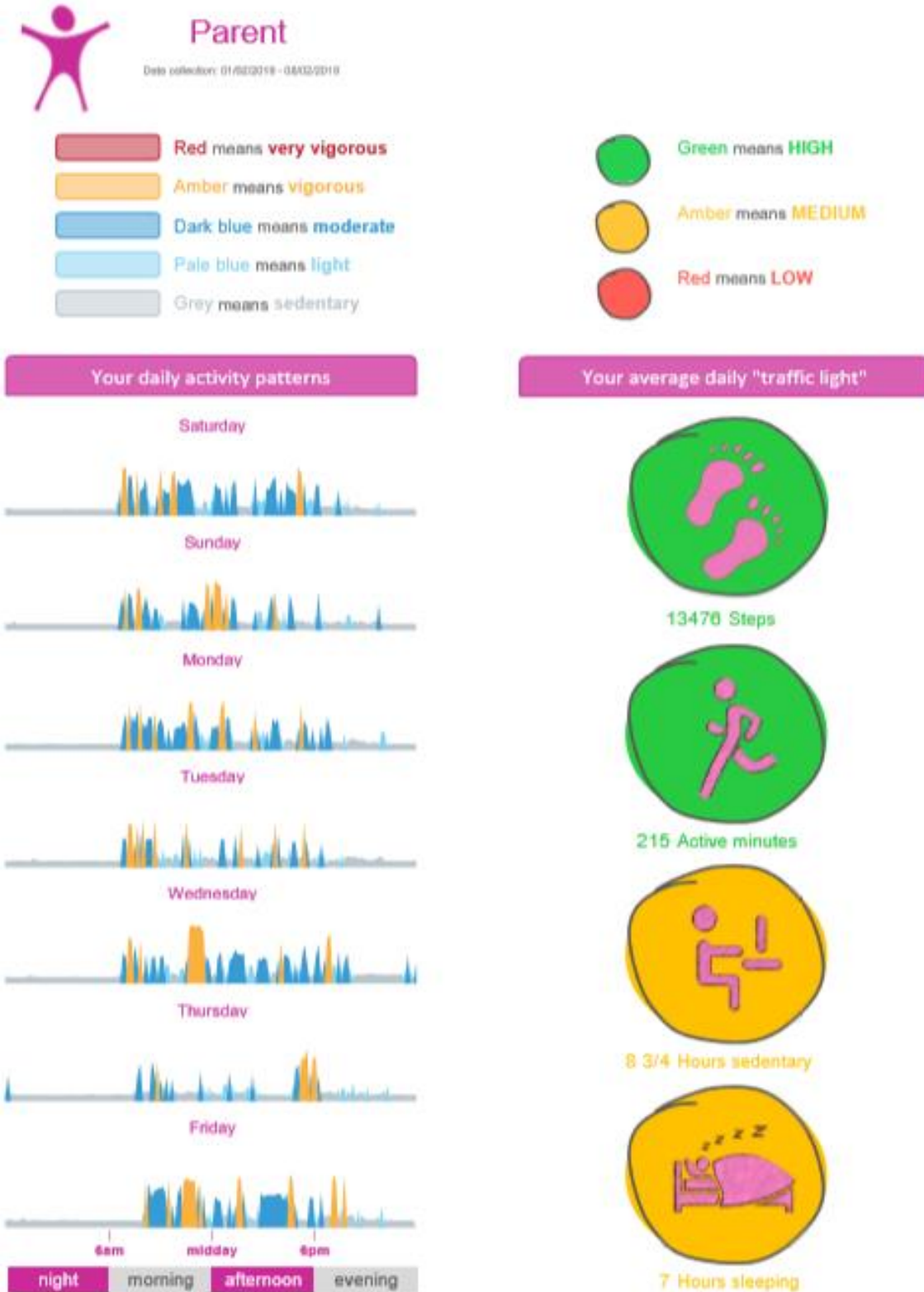
Signature _____

Date: _____

B. i) Example of Multidimensional Child PA Feedback



ii) Example of Multidimensional Parent PA Feedback



iii) Example of Parent and Child Sleep Feedback

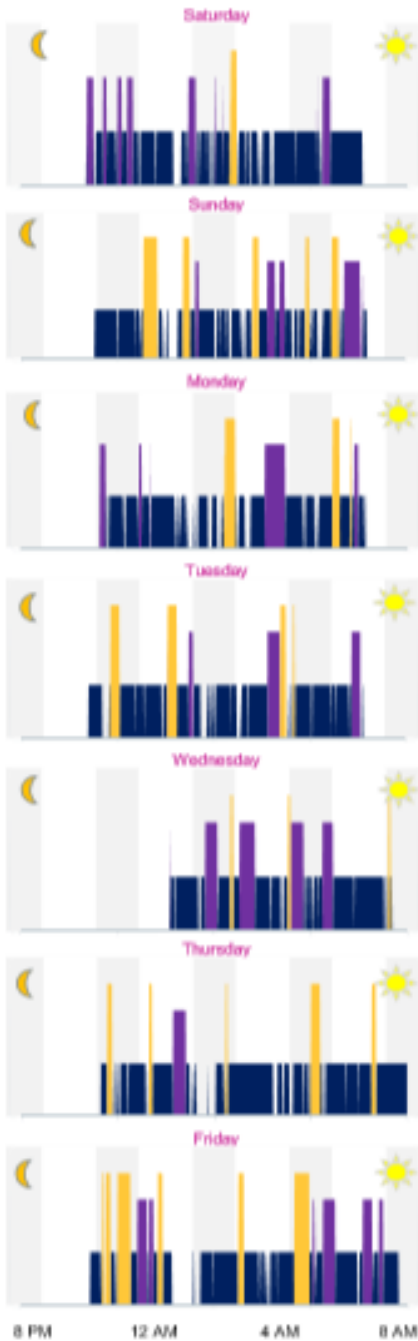


Parent & Child

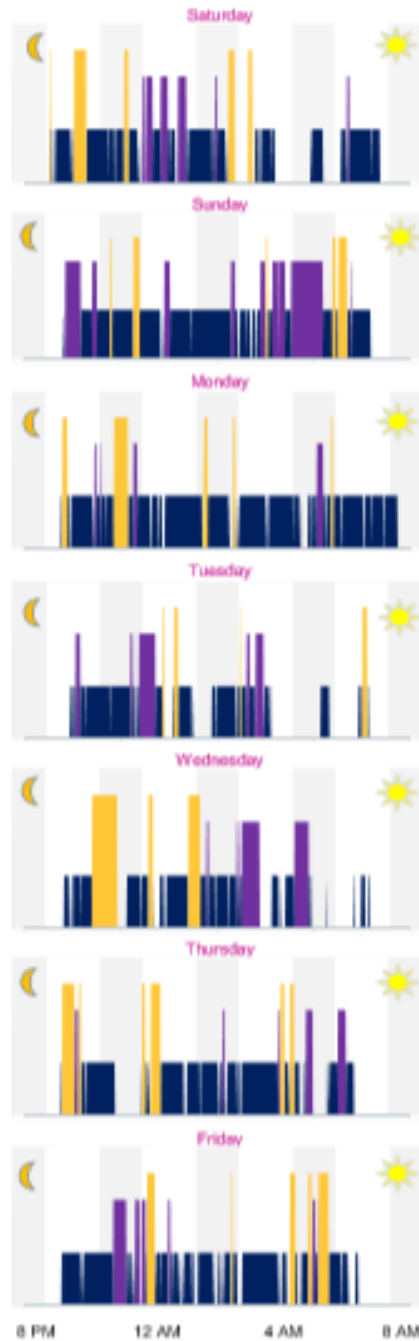
Data collection: 13/02/2019 - 26/02/2019



Your sleep patterns - Parent



Your sleep patterns - Child



C. Face to face interview guide

1. Introduction

- 1.1. How did you find wearing the device?
 - 1.1.1. Were there any specific problems that either of you encountered?
 - 1.1.2. Are there any things you liked or disliked about wearing it?
- 1.2. Do you have any further comments about the device itself?

Introduce Parent's Personal Profile

(Researcher explains how each section can be interpreted)

2. Impressions of parents' profiles

- 2.1. Are there any parts of the graphics that are still unclear that you would like to be explained further?
- 2.2. Now that you know what each section means what are your impressions of your own physical activity?
- 2.3. How does seeing your own physical activity data in this way make you feel?
- 2.4. Has the profile provided you with the information that you were expecting to see?
 - 2.4.1 If no, what was that information?
- 2.5. Are there any areas of the graphic which we haven't talked about that you would like to?

Introduce Child's Personal Profile

3. Impressions of child's profiles

- 3.1. Now that we have had a look at your physical activity, what are your impressions of your child's physical activity?
- 3.2. How does seeing your child's physical activity data in this way make you feel?
- 3.3. Has the profile provided you with the information that you were expecting to see?
 - 3.4.1 If no, what was that information?

4. Analysing the highs and lows

- 4.1. On.....your child spent some time exercising vigorously, do you recognise what this activity was?
- 4.2. On.....your child spent some time sedentary, do you recognise what they were doing here?
- 4.3. Are there any specific days which your child's activity levels are particularly surprising to you?
- 4.4. Are there any parts of the data in your child's graphic that stand out to you that you feel we haven't talked about?

5. Practical application of feedback

- 5.1. After seeing this data how would you describe the level of your child's physical activity?
 - 5.1.1. Has this changed from how you would have described it before receiving the feedback today?
- 5.2. Has this feedback changed the way you think about your child's physical activity in any way?
- 5.3. Are you happy with the amount of physical activity that your child is getting?
 - 5.3.1. If not what aspects are you not happy with?
- 5.4. Have any parts of this feedback motivated you in any way?
 - 5.4.1. If so, how?
- 5.5. On the whole, has seeing your child's physical activity data been useful?

Close

Thank you very much for giving your time to participate, if there is nothing you would like to add that is the end of the interview. Please feel free to ask any questions about anything we have discussed.

D. Examples quotes of how parents were asked their opinions about the impact that PA monitoring has on children

“Alright then, so you know how I said earlier about how kids have started wearing physical activity monitors? Well what are your thoughts on that in general?”

“OK so what is your opinion on kids wearing physical activity monitors?”

“So just quickly, what’s your opinion on kids having physical activity monitors to wear on their wrists, like Fitbits that type of thing?”

“So, one other thing I’d be interested in hearing your opinion on would be kids actually wearing physical activity monitors themselves...I just wondered what your thoughts would be if say your child decided she wanted one of these?”

“So, going back to the bands that you mentioned about, what are your thoughts on kids wearing a band like a Fitbit, which show you your steps etc.?”

E. Telephone interview guide

1. Introduction

- 1.1. General introduction enquiring whether the parent has time to answer questions surrounding the study that they and their child took part in.
- 1.2. Inform the parent that this phone call is being recorded for the purpose of the study.

2. Changes in parent's behaviours

- 2.1. Since being provided with your child's physical activity feedback have you made any changes in the ways you support your child's physical activity?
 - 2.1.1. If so what have you done differently?
- 2.2. When we spoke before about improving the ways you could support your child's physical activity you said that you wanted to ... have you managed to do this?
 - 2.2.1. How did this go? /If not, what got in the way?
 - 2.2.2. Why do you think you were/weren't able to make the changes that you had planned to before?
- 2.3. Would you say receiving this feedback has influenced the way you think about your child's physical activity in any way?

3. Changes in child's behaviours

- 3.1. Did you show the feedback to your child?
 - 3.1.1. What did they think of it?
 - 3.1.2. Have they made any changes as a result of receiving this feedback?
 - 3.1.3. If so how have the ways they act changed?

Close

Thank you very much for giving your time to give this feedback, if there are any further questions that you have please feel free to ask.

F. Quotations of parents (N=10) opinions on children wearing PA monitors

Lower order theme	Substantiating quotations
Group A: Some form of PA monitoring is beneficial and fun for children (n=9)	
Children enjoy wearing PA monitors	<p><i>"He was loving it [wearing the PA monitor provided during the study] ... showing it off to all his friends at school"</i></p> <p><i>"I think it's good [wearing PA monitors], like from my child having one previously he really enjoyed it"</i></p>
Important to raise children awareness of their own PA	<i>"But I would say that using technology to keep that front of mind, particularly at that stage of life, means they could embed it [being physically active] in their awareness and their habits"</i>
Children like a competition	<i>"I think for children they like...they like the competition element, so anything that's going to make them run around more, so they can beat their mates, is a good idea"</i>
Group B: Real-time PA monitors are a good motivator for children (n=3)	
Children are motivated by achieving goals	<i>"I think it's quite possibly a good idea [children wearing real-time PA monitors] in the sense that kids like targets, and if you can say 'right you need to hit this'...it's better than nothing"</i>
Children are motivated by rewards	<i>"With his Fitbit thing, every time he did 10000 steps he got like a little reward on the app and...he got to play a little game, or something like kind of unlocked, which was quite good"</i>
Group C: Would prefer their child to wear a real-time PA monitor rather than receive sporadic feedback on their PA (n=3)	
Rewards make real-time monitors better than sporadic feedback	<i>"I would say the Fitbit type thing...he loved getting his rewards for stuff and he still uses it now"</i>
Group D: Believe real-time PA monitors could be harmful for children (n=7)	
Displays mean that children can become obsessed	<p><i>"With a display permanently there, there is obviously the danger that it becomes slightly obsessive...and I would say intrusive, because it's constantly...often I feel that way about my phone... if you don't exert a level of discipline, which I think kids might struggle with, you can easily become a slave to it"</i></p> <p><i>"I think the Fitbit is a bit, like disturbing. If it's on your wrist... you're like 'oh how many steps have I done', I don't like that"</i></p>

Lower order theme	Substantiating quotations
Young girls are at particular risk of becoming obsessed	<i>"I do worry a bit...I can see problems with people wearing monitors, because there's an awful lot of young girls in particular with obsessions about weight and fitness"</i>
They put too much focus on achieving scores	<i>"If you just whack it on a child and it shows a number, when the child sees a number they see a score...all they absorb is the bigger that number the higher my score...but that's not healthy"</i>
They put too much pressure on children	<i>"I think it's important... not to put too much emphasis on the milestones, more about having fun rather than the pressure"</i>
Group E: Would prefer their child to receive sporadic PA feedback rather than wear a real-time PA monitor (n=6)	
Prefers the way feedback was given in the current study and how easy it was to forget you were wearing the monitor	<i>"If he was to wear a monitor I think I'd probably go for something similar to what you gave us...because it's not visible on there what he's doing...so potentially then it could be reviewed at home with us, rather than...like with the other kids"</i> <i>"For kids the thing you had is good. It's good because they don't get to think about it, they just move as normal"</i>
Sporadic feedback would be useful	<i>"I'd personally prefer it [receiving feedback in a review vs wearing a real-time monitor], I'd prefer it for myself, and I'd prefer it for kids, and I'd posit that it's actually more effective"</i> <i>"It would be interesting to do it again [receive PA feedback] on a quarterly or 6 monthly basis to see any changes people made, and while you think you made changes, were they sustained?"</i> <i>"I mean it's good to have feedback from time to time, like OK this is what's happening...it's like smoking or drinking, it's only when you receive that feedback that you are aware of what's going on"</i>
Downloadable feedback would be better	<i>"I would want something like...I use myself, to download the information at some point. To see how she's doing. I think that's a lot better than a Fitbit type thing"</i>
Group F: Children do not need to monitor their PA (n=2)	
Are PA monitors needed if kids are already active?	<i>"The question for me, is does the child really need to know...if she's already doing a lot of sports I don't think it's necessary"</i> <i>"Normally they move around so much that it's less of a concern. I would be more concerned about my wife and !"</i>