Pass the Ball: Enforced Turn-Taking in Activity Tracking

John Rooksby, Mattias Rost, Alistair Morrison, Matthew Chalmers
School of Computing Science,
University of Glasgow, UK.
{firstname.lastname}@glasgow.ac.uk

ABSTRACT
We have developed a mobile application called Pass The Ball that enables users to track, reflect on, and discuss physical activity with others. We followed an iterative design process, trialling a first version of the app with 20 people and a second version with 31. The trials were conducted in the wild, on users' own devices. The second version of the app enforced a turn-taking system that meant only one member of a group of users could track their activity at any one time. This constrained tracking at the individual level, but more successfully led users to communicate and interact with each other. We discuss the second trial with reference to two concepts: social-relatedness and individual-competence. We discuss six key lessons from the trial, and identify two high-level design implications: attend to "practices" of tracking; and look within and beyond "collaboration" and "competition" in the design of activity trackers.

Author Keywords:
Activity Tracking; Mobile Health; Game.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
The potential for smartphone-based activity trackers to support and encourage health related behaviour change has been widely recognised (see [14, 16, 18] for recent overviews). We have noticed that activity trackers are commonly designed as individual trackers that then have social features added to them. Typically, social features enable users to post an achievement such as a recent run or step-count to a social network site such as Facebook. In this paper we explore a social-first approach, reporting on an app we have developed and evaluated that takes interacting with others as prerequisite to tracking an activity. The app, Pass The Ball, is a team game in which players pass a virtual ball to each other. Only one user can have the ball at any one time, and only this user's activity can be tracked by the app (the app awards activity points based on a simple motion tracking algorithm). Teams compete against each other to score the most points. This creates a coordination problem, one that requires users to think about and discuss not just their own activity but also that of others.

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ACM 978-1-4503-3145-6/15/04...$15.00
http://dx.doi.org/10.1145/2702123.2702577

For this work we adopted a "*research through design*" approach (see [13, 36]). We have created a mobile application and have studied its use in the wild on people's own mobile phones. We have gone through this process iteratively (as is best practice in design [36]), producing and trialling the app for two weeks, then refining it and trialling it again for another two weeks. Gaver [13] argues that research through design is not about creating artefacts that embody, confirm or falsify theory, but artefacts that can be "*annotated*" by theory. In this paper we use two concepts from behaviour change theory as annotation: individual competence and social relatedness. Our work does not embody, confirm or falsify any particular theory, but treats these concepts as a way of discussing the relationship, similarities and differences of Pass The Ball to other activity trackers. Gaver views design not as a science, but as a process in which "*we may build on one another's results, but ... also usefully subvert them*" (p.946). Our app is subversive in that it prioritises social-relatedness over individual-competence, where the converse is the norm.

BACKGROUND
Pedometers have been widely available for a long time (they were introduced, in their modern form as step counters, by Yamasa in the 1960s). Recently, smartphone applications (apps) and networked hardware devices have begun to offer new possibilities for tracking steps and myriad other activities, sparking renewed interest in the relationship between tracking and health related behaviour change. Pedometers have been shown to have a positive effect on health related behaviour [34], and it seems a reasonable expectation that apps and networked hardware devices can have similar if not greater benefits. Studies such as [3, 4] are pointing to and cautiously confirming such benefits. However, with the range of new possibilities comes a large, complex design space; it is only beginning to become clear what the effects and relevancies of different designs are to behaviour change. In this paper we discuss our exploration of this design space.

Over the last few years, researchers and developers have been creating apps and devices that augment tracking with social and game features. Apps such as SpyFeet [30] allow

stories to be unlocked and quests to be achieved. Applications such as Fish n' Steps [21], and Ubi-Fit Garden [8, 10] reward activity with badges or virtual animals and items. Applications such as Houston [9] StepStream [25] and Shakra [1, 24] allow users to compare activity levels with others. Applications such as NEAT-o-Games [12] and American Horse Power Challenge [35, 26] focus more overtly on competition with users competing in a virtual race. Commercial activity trackers, including smartphone applications such as Moves and Endomondo and hardware devices such as FitBit, Nike Fuelband and Jawbone UP also offer a range of functionality including tracking, game features, and options to share data with others. In this paper we will use the term "activity tracking" with reference to the quantification of physical movement.

Individual-Competence and Social-Relatedness

There are many theories relevant to behaviour change [10, 15, 33]. These commonly address the importance of gaining an understanding of one's own behaviour and any necessary changes, as well as the importance of social support. For example, Self Determination Theory (SDT) [29, 33], states that persistent behaviour change occurs readily when people internalise new skills and values. The three psychological needs that internalisation requires, are *competence, relatedness and autonomy*. We annotate our study with respect to two of these. As is common in research studies, we have asked people to use a tracker (our app) for a short period, and have paid them to do so. SDT and other behaviour change theories state that it is important that activity is engaged in with a sense of choice and personal endorsement (i.e. with *autonomy*). Although we instructed participants to use the app as much or as little as they wanted, there are subtle pressures involved in recruiting and paying participants, and ultimately there is little we can claim about autonomy, internalisation or long-term behaviour changes. Our study focuses more narrowly on individual-competence and social-relatedness over short term. This is a narrow treatment of the concepts, which are articulated in the literature not just with respect to "early action" but also the medium and long term.

Individual *competence* is the ability to understand one's own behaviour and whether and how to make changes [31]. To be competent is to be able to measure or otherwise conceptualise an activity, and to be able to recognise and meet sufficient targets. For example, pedometers provide step count measurements, and can be used in conjunction with relevant goals. Someone may have little idea of how many steps they take a day before using a pedometer, and should they find they are taking too few, an appropriate short term goal might be a 10% increase, rather than to aim for a potentially unobtainable number such as 10,000. In terms of competence, activity trackers: enable diverse activities to be tracked; provide more flexible ways to present and examine data; and provide ways to develop exercise regimes, set goals and remain motivated.

Social-relatedness refers to the extent to which one feels understood by, supported by, respected by and connected with others [31]. Social relatedness can manifest in various ways, including: going through a change with others, having social support from family, and understanding how you are placed generally within a population. One pertinent issue to be raised here is that competition can be de-motivating, particularly if one regularly loses the competition. Chen and Pu [7] have shown that people are more motivated by a cooperative activity tracker app than they are a competitive one. Regarding relatedness, modern activity trackers offer many opportunities for sharing, comparing, competing and collaborating. Community focused initiatives involving walk-a-thons or online forums in conjunction with tracking hardware (e.g. [30]) have often shown greater benefits to a population than individualised approaches.

Putting Social-Relatedness before Individual-Competence

Social features in activity trackers are often optional, and typically designed for sharing and comparing data about tracked activity. As such, social relatedness is typically treated in design as subordinate to individual competence. For example, running apps often enable users to track a run and afterwards to post data about it to a social network site. The design of Pass The Ball reverses this, putting social-relatedness before individual-competence; one must engage socially before tracking activity. This is a re-ordering of, rather than re-specification of design features. Consolvo et al [9] list design requirements that include "*provide personal awareness*" and "*support social influence*". We meet these requirements, but in reverse order and with emphasis on the latter over the former. Clearly we are making generalisations here that lump together diverse activity trackers. Some trackers, notably StepStream [24], strongly emphasise relatedness, but the work we present in this paper pushes to an extreme by making social interaction prerequisite to tracking.

PASS THE BALL

We have developed an app for iOS and Android devices called Pass The Ball. The app uses the accelerometers in these devices in order to quantify a user's physical activity. It is a team game that enforces a turn-taking mechanism, requiring that only one team member can track their activity at any one time. Teams compete in a league. The Pass The Ball interface is shown in figure 1. It has three tabs, or views, that respectively show the home (main) view, the current league standings, and tools to set preferences for notifications and to update profile pictures. The app has the following functionality:

- When a user registers, they join a team. Each team has a virtual ball, which only one player on the team can have possession of at any one time. When a player receives the ball, the app starts tracking that player's activity. After one hour, or if the player passes, it ceases tracking. Only the player with the ball has their activity

tracked. The user with the ball can also pass the ball to any other user on their team. Passing the ball switches off tracking on the passer's device immediately. When the receiver has accepted the pass, the receiver's device begins tracking.

- The activity tracker is built into the app. It is based upon an algorithm defined by Libby [20]. It quantifies steps or any other moderate or vigorous physical movement (the word 'steps' is not used in the game, and as we will discuss, the participants scored points from a variety of physical activities including shaking, jumping, and cycling). A user's activity, as quantified by the app, contributes to the team's overall score. Users can view their team's score and the scores of other teams. Teams compete in a weekly league (see the right of figure 1).
- When the tracker is not active, players can take possession of the ball through interception. Interceptions incur a deduction of 1000 points from the team's overall score. This is possible in two circumstances: firstly, if the player with the ball has used the tracker for the maximum one hour period, but not passed the ball (in which case, every team member except the one with the ball has the option to intercept it); secondly, if a ball has been passed but the receiving player has not tapped the receive button (in which case every team member except the pair making and receiving the pass has the option to intercept it).
- Users can write comments in the app, which are visible to all other team members, appearing on the same timeline that shows passing and activity data. Players are able to view the activity of other teams, but cannot view comments made by other teams.
- Team activity is presented in the app on a scrollable timeline (see 'The Home View' in figure 1). The timeline is updated every time a comment is made, and every time the state of the ball changes (for example when a pass is made, when the tracker is turned on, or when an interception is possible). When a player turns on their tracker, a visualisation of their activity is displayed together with the points they have scored. The visualisations can be seen by all teams.
- Users can receive notifications when passed the ball, when they have used the pedometer for more than one hour, and when comments and passes are made. Users can configure the types of notification they receive.

Pass The Ball runs on both iOS and Android, enabling teams to have members with different devices. Because we wanted the game to be played by existing social groups, it was important to support a range of popular devices. We also wanted players to be able to use their own personal devices, as we were interested in how the game would be integrated with everyday smartphone use. The final version of Pass The Ball was implemented as a hybrid mobile web app, meaning it is run as a native application but content is displayed using HTML5. As much as possible of the app is implemented as a web app hosted by our servers (meaning the interface was standard across devices). For Pass The Ball, counting and uploading steps is run natively as it needs to be run in the background—something that cannot be done for a pure web app. Delivery of push notifications also needed to be handled natively. Points are uploaded to the server every minute. We sought to create a feeling of 'liveness' in the app, whereby players could observe their teammates' activities in near real-time. We also included icons in the league view to show which teams currently had a player 'on the ball' whose activity was being tracked.

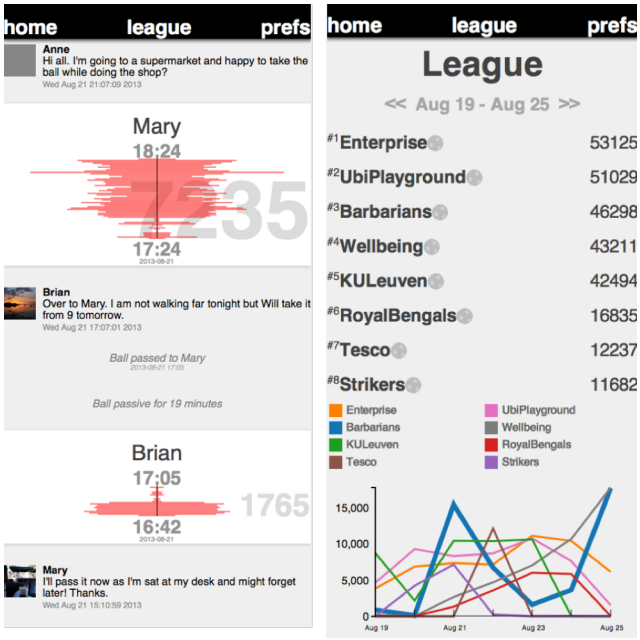

Figure 1. Pass The Ball: Home view (left) and League view (right). Names have been changed. Both views are scrollable.

The Iterative Design Process and Initial Findings

The version of Pass The Ball outlined above was arrived at through an iterative design process. We developed and trialled an earlier version where the pedometer was constantly on for every player. Each team had a ball, and only the player with the ball could score points for their team. The idea was that each player could use the pedometer individually, and that the ball passing functionality would encourage players to examine and discuss each others' activity, discussing good passes, as well as 'missed passes' (i.e. times when a player without the ball had high levels of activity). Pass The Ball version one was trialled with 20 players, making up five teams, in a two-week competition. It was an 'interesting failure'.

The primary reason that we considered the first trial a failure was that the ball was passed infrequently. The game advantaged players that were already highly active, and we found that these players would retain the ball to the

exclusion of more sedentary teammates. One team passed the ball a lot in the first four days. They coordinated passes by planning ahead, announcing that they were going to go for a walk at a specific time, and asked for the ball to be passed when they knew they were being active. However, they realised that the best strategy for them in game terms was to let the most active person in the team (who worked as a bicycle messenger) keep the ball indefinitely. This problem was serious because there soon became no need to communicate with others in the game. Another team reported frustration that one of their players just kept the ball; they requested a way of intercepting it. A secondary problem concerned battery drain on iOS devices, which was unacceptably high for several users (the drain was no higher than for commercial apps such as Moves, and we note that this issue has been resolved for recent iOS devices with the inclusion of a coprocessor with a dedicated pedometer).

Following the first trial we decided that only the player with the ball should be able to turn on tracking and that it should switch off after one hour if the ball has not been passed. We added the interception feature at this point, so that if someone fails to pass the ball the whole team does not become stuck. During the design session in which we decided these changes, we recognised that a key issue with this new design is that individual users cannot track and quantify at will or over the course of a full day. It was at this point that we became intrigued by the question "*what happens when social-relatedness is prioritised over individual competence in tracking?*"

USER TRIAL

We report here on our trial of the final version of Pass The Ball (the version as set out with bullet points in the previous section). This was the second formal trial we staged during development and evaluation. This trial was run over a two-week period.

Method

Our trial followed the approach and rational set out by Brown et al [5] for trialling applications in the wild. Participants ran Pass The Ball on their own devices, with deployment handled through ad-hoc distribution. Usage and activity data from players' apps was logged during the trial. This included scores, player communications within the app, as well as timestamped screen changes by each player. All participants were interviewed following the trial. We analysed the interview transcripts in an iterative manner alongside the log data. Our analysis is primarily qualitative.

Participants

Thirty-one participants were recruited (twenty female, eleven male, age range ~20 to ~40). Participants were recruited through advertising and a snowball approach. Because we wanted existing social groups to participate, snowballing (i.e. asking participants to invite friends and relatives to play) was important. None of the participants had participated in the first trial. The participants were each given an information sheet that gave an overview of the app, explained what data we were collecting and how this data would be stored and used in our research study. The sheet stated that participants could play the game as much or as little as they wanted and that they were free to withdraw at any time. Participants were paid 10 UK pounds (or a Euro equivalent) at an interview at the end of the trial period. Participants were neither coached nor encouraged during the trial. Participants that did not already know each other were kept separate during deployment and interview.

The participants formed seven teams. In six teams, every player knew his/her teammates, as friends, relatives or co-workers. A seventh team, given the name Barbarians, was formed by us from a group of strangers who did not know each other. Participants were resident in the UK and mainland Europe. Some participants travelled during the two-week period, but otherwise all but the Barbarians team consisted of players that saw their teammates on a daily or regular basis. The teams ranged in size from two to seven people. Not everyone started at exactly the same time, and not everyone participated over the full period, as we detail below. From here on, abbreviated team names are given, e.g. Barbarians will be denoted as BAR. Players within teams will be referred to as BAR1, BAR2 etc. Table 1 summarises the team information.

Four teams remained in the game to the end of the second week. One of these, ROY, entered the game two days late. Three teams stopped scoring before the trial period had finished, (although our logs show some players in these teams continued to view the scores). Reasons for non-participation included KUL: players travelling abroad (data would have been charged at high rates) and focusing on a deadline; STR: players travelling abroad; TES: limited mobile data and Wi-Fi, and disinterest in tracking. The design of Pass The Ball meant that players were reliant on other team members, and so the withdrawal of one or more individuals could cause participation problems for others. It should be noted that it was the three smallest teams that did not compete over the full two weeks.

FINDINGS

Our findings are organised with respect to the concepts of *social relatedness* and *individual competence*.

Social Relatedness

All of the participants reflected at length in the interviews on the collaborative and competitive aspects of the game.

Collaboration: Passing and Intercepting

To score points, it is essential for teammates to pass to each other or to intercept. Players indicated during interviews that the early passing decisions were largely uninformed, and often made as gestures of inclusiveness (for example with new members being passed the ball upon entering the game). Several teams developed more organised strategies as the trial developed, with later passes being made either according to requests, or prospectively according to knowledge of others' routines.

Team	Team size (m,f)	Passes / Interceptions / Comments	Relation	Score Week 1	Score Week 2
BAR	(2,5)	68 / 4 / 128	Strangers	46298	93678
WEL	(3,4)	50 / 13 / 97	Colleagues	43211	63457
ENT	(0,6)	66 / 2 / 42	Colleagues	53125	33657
ROY	(2,2)	22 / 1 / 6	2 couples	16835	62512
KUL	(3,0)	23 / 0 / 30	Colleagues	42494	533
STR	(1,1)	45 / 0 / 3	Siblings	11682	0
TES	(0,2)	7 / 0 / 0	Friends	12237	0

Table 1: Team composition and engagement levels (ordered by team size)

Examples of requests and planned passing appear in the comments in figure 1. Some requests were seeking the ball to be passed immediately, but most would book the ball for a specific time. Some bookings involved the negotiation of clashes, and tight coordination of passes (a problem being that many teams found they had a similar routine, e.g. they would walk to work at similar times). Eventually, passes were made prospectively without the receiver needing to make a request (we refer to this as 'prospective passing'). In figure 1, Brian can be seen to pass to Mary prospectively (in time for her daily cycle ride home). This reliance on knowing others' routines worked better on some days:

> *"Weekends were very problematic because we never knew where anybody was going to go when"* (interview with KUL1).

The reliance on routine also came to favour some players more than others. So, while several members of the BAR team attributed their success in the second week to an orderly scheduling regime, BAR7 (who joined the BAR team late) noted that it felt like the initial team members were already well organised and that she felt it was hard to fit in. BAR7 also complained in interview that the others in her team seemed to have a good sense of what they were doing, but that her own life lacked the kind of structure necessary for prospective passing (this player was a student, whereas several others in this team had regular jobs).

The in-app communication was one of several means by which teams coordinated themselves. Only the TES team did not use the in-app channel at all. With the exception of the BAR team (who were strangers and had no contact outside of the app) all teams reported talking about the game face–to–face, and through email and social media. The ROY team informed us that they had created a Facebook group chat through which they arranged passing schedules. The KUL and WEL teams preferred email to the in-app comments, as this was viewed as a more reliable way of getting through to colleagues:

> *"We started using the comments … but it's easier for us to look at email on the computer. I say, hey pass me the ball because I'm going out to the office, I'm going out to this place and I'm going to walk"* (interview with KUL1)

Even though the design of the game meant players did not have to reveal their total daily activity levels, and enabled players to 'stand back' from tracking if they wished, players reported concerns about how they were being represented to others through the application (even to strangers).

> *"It does feel a touch narcissistic. Its like, yeah, I'm going to the gym, aren't I amazing"* (interview with WEL3).

> *"I didn't want to just ignore [the game] because that makes it look like I never do anything"* (interview with BAR7).

We also found from the interviews that practical privacy issues impinged on coordination. Members of the BAR team reported announcing when they expected to be active, but deliberately keeping details vague to avoid revealing information on location or activity to strangers. For example, one participant said she was vague in reporting where she was going because she did not want to reveal she had children. Interestingly, perhaps alarmingly, another BAR speculated in interview that this player was a mother because her activities included shopping and museum visits during the day. The WEL and KUL teams were more concerned about work/life separation, and did not feel comfortable discussing weekend activities with co-workers:

> *"It's kind of like down time, out of work. You don't necessarily want your colleagues knowing what you're doing, at the weekend, in the evening*" (Interview with WEL2).

The activity patterns of others were examined and interpreted not just with passing in mind. Some unanticipated usages included colleagues or those within a household looking at activity traces to determine whether someone was on their way home, or what time they had gone to work (further underscoring the privacy and identity issues raised by the application).

Interceptions in the game were rare; only twenty interceptions were made (thirteen of which were in the WEL team, five by one player). In the words of BAR2, interceptions "*really paid off*", yet most participants did not like to intercept or for others in their team to do so. BAR2 spoke of needing "*confidence*" to intercept, and said that this explained why it was getting done more often in the second week once the team dynamics were more established. Players who had not intercepted confirmed in interviews that they had understood the feature, but we found players were generally averse to point deductions, even when the team stood to make overall gains by using an interception to restart activity after the ball became passive. Interceptions were often perceived as socially unacceptable. As an example, one interception provoked the following

exchange in the in-game communication, when BAR7 intercepted a ball left passive by BAR4:

> *BAR4: Sorry, Just looked at my phone. I would have passed!* (In-app comment)

To which BAR7 responded:

> *BAR7: Yeah sorry [BAR4]. Was heading out then but don't leave the Internet on when I'm not using it so thought I'd just take it.* (In-app comment)

This exchange (between two British players) features two insincere apologies. BAR4 apologises yet castigates his teammate. BAR7 apologises but then states how she manages data connectivity on her phone. In interview, BAR4 singled out this incident as a point of annoyance:

> *"[She] nicked the ball off me, I hadn't passed it for an hour cos nobody had said they wanted the ball. [She] took the ball off me to lose 1000 steps of my 1500 I'd put on."* (interview with BAR4).

The language here is interesting, in that BAR4 felt that the ball was "*nicked*" (i.e. stolen) from him. He took the points loss personally, as if the points were taken off his own rather than the team's overall score (other players reported similar feelings). BAR7, we mentioned earlier, is a student and had reported that she was less able to keep a schedule. She saw the app more as something to use opportunistically when the desire arose. Therefore her perception of this interception was different to that of BAR4.

> *"So [BAR4] was like 'oh sorry, I would have passed it'. But this was 10 or so minutes after I'd intercepted it. And it's like, well I'm going out NOW, do you know what I mean?"* (interview with BAR7).

This incident is one of many revealing that passing and intercepting were seen as moral decisions. Failures to pass were also oriented to morally, for example, the following apology is for not accepting a pass at a 'booked' time:

> *BAR6: Sorry was rushing for a meeting and forgot!* (In-app comment)

That there was a moral order to play does not mean that team members saw eye-to-eye on what was the right thing to do, but does mean that with collaborative play came responsibilities and expectations among team members.

Competition: Viewing the League and Other Teams

It was evident that all players were working cooperatively with a view to working their respective teams up the league. However, differences in the competitiveness of individual players were apparent. Some checked the league and drilled down into the activity of other teams frequently. Participant ENT4 said that she "*got a bit obsessive*" about checking league positions, yet others did not take such an interest in the updating league table; even within the ENT team, the usage logs reveal one participant checking once every two days, and another checking up to thirty times a day.

We were informed that under some circumstances, competition could motivate activity:

> *"When you have the ball, and if your team score was close to that whoever you were close to or overtaking… it's certainly very motivating to do those extra steps, if you could take over a team, while you've got your turn then that's quite pleasing"* (interview with BAR2).

> *"I was on a work day out, and I turned to my group and I was like 'we're walking fast today! We have an hour to get as many steps in as we can!"* (interview with BAR3).

Although some players barely looked at the league, they were kept informed. Other players would comment in the game on their team's position, and some reported in interview about being driven by competitive teammates. For example ROY1 recounted of his wife ROY2:

> *"She used to go inside those teams and see who is the active person, and she identified a girl… She said there is a girl and she scores most… She said OK, this girl probably took it seriously so we have to score more"* (interview with ROY1).

The "*girl*" in question was BAR6 (also referred to as Mary in figure 1), who cycled to and from work. Figure 1 shows BAR6 scoring several thousand points over a relatively prolonged and intensive period. She was noticed by many players, but oriented to in different ways. In her own team, one of her own teammates saw her as "*hardcore*", serving less as a motivator and more as a figure with authority and someone important to get the ball to. In other teams (who could see her activity but not her comments) she inspired competitiveness (e.g. ROY1's comment above). As we will discuss, in the STR team she was suspected to be "*a cheat*".

Individual Competence

The participants all spoke at length about their understandings (and sometimes misgivings) about the tracker and points system.

Concepts of Activity

Participants used the tracker for many kinds of activity. Activities referred to in in-app comments include walking, running and cycling, but also less specifically exercise-oriented day-to-day actions such as "*pottering*", shopping, and housework. For some participants, everything counted:

> *"Every time there is motion we tried to utilise that motion to score"* (interview with ROY1).

The ball would rarely be booked for such (low scoring) day-to-day activities, particularly after a few days of use, but rather it was done opportunistically. The tracking of more intensive activity was often preferred over less intensive activity. Therefore, in some respects the app favoured people who were relatively active.

In the interviews, and from a close examination of the in-app comments, it became evident that the tracker was

inspiring certain activities and changing how some were done. In some cases the game inspired activity:

> *"We don't move that much. Its very good exercise for us."* (interview with ROY1 and ROY2 – a couple).

The activities of ROY2 and others were not just more of what they ordinarily did, but were activities invented for the app. ROY2 recounted spending a night jumping up and down with ROY1 (in a mix of excitement and points scoring) to the point that their downstairs neighbour complained. The STR team initially experimented with point-scoring activities and found a form of upper body stretching exercises they were happy with. However, on looking at other teams' activities, and in particular that of the high scoring player BAR6, they were less sure of the relevancy of this. They began to focus more on walking. They described in interview their experiments with how to score when walking, explaining how they found holding the phone in one hand and swinging it proved a good strategy.

Whereas ROY1 had seen BAR6 as an inspiration, motivating them to do further exercise, the STR team was motivated by BAR6 to, in their own words, "*cheat*". The STR team were suspicious that BAR6's scores were not being scored through legitimate means, and gave up their stretching to seek methods that would score thousands rather than hundreds of points. They explored forms of shaking the phone. However, STR reported that their shaking efforts were themselves "*hard work*" and they failed to replicate the levels of activity BAR6 had produced.

Shaking appears to have often occurred in the game when players examined others' activity traces. KUL also reported shaking the phone; in this case the team member had tried shaking the phone as he cycled. Again, this was hard work and the participant reported nearly dropping his phone. Shaking became something of an art for some players:

> *"You need to have a special pressure that gives the phone a feeling that a step has been taken. I mean if you just shake like this, probably it doesn't work, but if you shake like this … you need to have your finger this way"* (interview with ROY1).

ROY2 responded to ROY1 by saying: "*No. Not like this, you should do it like this…*" and demonstrating an alternative shake. In general, those participants who reported shaking were only doing so on an experimental basis, to test the tracker, or as a means of verifying whether others might be cheating. Most reported that they would prefer to compete on a 'fair' basis, e.g.:

> *"It seems more fun like, if you're actually genuinely doing some activity to see what I was scoring rather than just trying to do something to cheat it… if we'd won it and we'd all done that, it would have seemed a bit rubbish"* (interview with ENT1).

Only the TES team appeared to have little compunction about shaking the phone. They admitted in interview (once we had assured them they would be paid no matter what) to have used the app while walking once, and after that to have simply shaken their phones a few times. They said this was not fun, and we note they used the tracker only a small number of times.

Understanding the Scores

The representation and quantification of activity in Pass The Ball was deliberately ambiguous. The game gave a visualisation and a points score, but did not specify what these points meant. In our interviews we found many participants were concerned with whether the activity points they and others gained were reasonable. Many participants did not have a firm idea of what activity should score what points. As we mentioned earlier, participants used the tracker for various activities, yet many oriented to points as if they were steps. Activities all scored 'steps'. Attempts to verify the tracker were with regard to steps. Several spoke of trying (and failing) to count steps as they walked. Several spoke of trying (and failing) to watch their score increase when walking with phone in hand. One participant got further by looking up information online:

> *"I did look up one time to see, there was like a government statistic to say that in 10 minutes you should do x amount of steps … 'cause I was wondering, is it far too much?"* (interview with ENT4).

The main complaints we received about the meaning of the tracker concerned not any discrepancy between effort and points scored, or the forms of activity that could be tracked, but consistency. Consistency appears to have become the main resource for participants in assessing the quality of the tracker. Participants were disconcerted when there were differences in what they considered to be equal activity:

> *"[ENT2] and I go out for a walk at lunchtime, and we saw two days where once she had the ball, and once I had the ball, and it was totally different results and we knew it was the same walk"* (interview with ENT1).

Most participants, however, noticed through playing the game that how a phone is carried can affect the score. ENT5 had noticed that carrying her phone in her bag scored twice as many points as in her pocket, surmising that the bag provides more motion:

> *"My bag kind of sits here (points at hip) so it bounces off my leg"* (interview with ENT5).

Some participants also noted that some phones seemed more generous than others, putting this down to variations in hardware. One player with a new iPhone believed he had an advantage over the others in his team who had older devices. We report this view not because we support it, but because it reveals ways in which users tried to make sense of the scores. Other forms of practice and sensemaking concerned consideration of data plans and network access. For example BAR7's participation in the game was shaped by her wanting to minimise data use and a desire to

conserve battery. Different practices of phone use were also made topical by the game, for example whether phones were carried during mundane activities such as housework or vigorous activities such as running, simply when people had their phones on or off, and how and why it was that people attended to notifications or checked the game.

To summarise, we have seen how an activity tracker can be flexibly interpreted, with interpretation interwoven with the activities being tracked, i.e. each being a resource for understanding the other. The phone itself was not simply an abstract vessel for tracking, but was a practical part of the sensemaking of tracking.

LESSONS LEARNED FROM PRIORITING SOCIAL-RELATEDNESS OVER INDIVIDUAL-COMPETENCE

Our work was not a controlled study, but an explorative design study in which we trialled an app in the wild. Therefore, our lessons learned are discursive and reflective.

1) Players were accepting of the turn-taking constraint to activity tracking and communicated with each other.

Firstly, we have found it is possible to enforce cooperation within an activity tracker and for the tracker to remain playable, enjoyable and acceptable to a majority of users over a two-week period. It is interesting and somewhat surprising how accepting the players were of a design that inhibits self-initiated and comprehensive gathering of personal activity data. This does not mean, from a behaviour change perspective, that the design of Pass The Ball is in the players' interests, but does suggest that users are open to novel designs in this area. Indeed, by minimising battery consumption, the design of Pass The Ball made the game more acceptable than an always-on tracker. The key problem concerning acceptability and use was not to do with tracking, but that individual non-participation could curtail the functioning of the whole team. Players relied on other players remaining active in the game. Smaller teams did not last the full trial period.

2) The app better highlighted and supported routine behaviour than it did non-routine behaviour.

The coordination mechanism we have presented enabled players to discuss and otherwise gain a sense of others' routines, such as their commutes to and from work, and if and when they would go running and cycling. Routine was the primary coordinative resource (although some players did report taking longer routes or jumping up and down purely for game purposes). Players relied heavily on routine to the point that some people that did not follow a routine felt excluded. Routine served as a resource for both planned passing, and booking the ball. As such, the game did see participants getting to know what sorts of activity people do on a day-to-day basis. Some players reported this was individually motivating, however we did not see much explicit encouragement among groups for players to increase their activity levels.

3) Players sought practical ways to manage identity and privacy when using the app.

Identity management was an important consideration for players (confirming [17, 23]). Several players reported wanting to be seen to be active and feeling good when they scored highly. But we also found that players wanted to maintain privacy, and that this manifested in contextually specific ways. For example, among strangers, players wanted to hide location and family status, and among colleagues, players were sometimes reluctant to reveal weekend activities. By not having tracking always-on, players can stand back from tracking if they do not want to reveal activity or inactivity. However, the passing mechanism meant players often had to supply written detail about what they would be doing when. This reliance on language exacerbates and transforms identity issues.

4) Players oriented to and experienced collaboration and competition in different but colliding ways.

Coordination and competition was experienced and interpreted differently by players, and these differences melded and clashed in the game. Some found the coordination (i.e. passing) mechanism to be enabling and motivating, but as we have mentioned, it suited those able to plan or follow a routine. Some participants were more concerned with competition elements than others, but those who were not interested seemingly could not escape the competitiveness of their teammates. To call the game 'social' is to gloss over that it was played and experienced within a moral order. In terms of coordination, this manifested as expectations that players would keep to their word when booking a session, and a preference for organised passing (as opposed to opportunistic intercepting). In some respects then, the game was socially awkward (see [15]). In terms of competition, this manifested as hopes and sometimes requests that others would push towards overtaking other teams, and as suspicions as to whether competitors were somehow cheating (findings that reflect [12, 21, 24]).

5) The practices by which players made sense of activity tracking evolved during play.

Players' concepts of activity, and the relationship between activity and points, were not pre-given or static but unfolded over time. We are reminded of Barkhuus et al's [2] simple but important point that tactics develop and evolve during gameplay. Players discussed with each other and experimented with what activities the game could quantify and by how much. Some teams were forced to rethink what they were doing when they saw others' scores. This was not necessarily to engage in more vigorous activity, but could be changing how the phone was held or carried when doing an activity. The game also evinced what some considered cheating (we are ambivalent to cheating, as [6, 32] note, shaking a tracker can be hard work!) We found that players were not moved by the game to shake the phone on more than one or two occasions. All participants were interested in the accuracy of the tracker. Some decided

that it was accurate, others that it was not. Accuracy was primarily considered with respect to 'steps' (even though this term was not used in the game).

6) Competency and sensemaking in activity tracking concerns the whole device, not just in-app data.

Finally, in the light of the discussion above of sensemaking, we suggest that 'competence' is not limited to the interpretation and use of data but extends to its production (somewhat reflecting points in [23, 32]). For example, players considered and discussed how scores could be affected by the physical handling of a device, and came to consider other relevancies to play such as network connectivity. Several participants were also aware that an accelerometer-based game played across varied Android and iOS devices is inherently problematic.

GENERAL IMPLICATIONS

Above and beyond our immediate lessons learned, through this work we have come to two general implications for designing activity trackers in the context of HCI research.

1) Attend to people's "practices" of tracking.

By studying how people use a tracker collaboratively, we have come to study *practices* of tracking. By getting people to communicate about tracking and to consider both their own and others' data, we have found that people orient to and develop ways of making sense of data. The data is not a mirror of activity but a medium for understanding it. We do not think this phenomenon is unique to Pass The Ball, but rather something made visible by our app and our research methods. The overriding design issue here is that high-level, user experience issues are at stake in activity tracking. These issues cannot be partitioned to the 'relatedness' and UI aspects of design but pervade the 'competence' and measurement aspects also. In sum, to successfully design social features in activity trackers, we must carefully consider the lived aspect of tracking. The "practice turn" in HCI [19] and Behaviour Change [28] is relevant for understanding activity tracking.

2) Look within and beyond "collaboration" and "competition" in the design of activity trackers.

There are many design alternatives when considering social features in activity tracking. This is often treated in broad terms, for example prior work such as [9, 7] talks broadly of "competitive" and "collaborative" trackers. We see a need for a more nuanced view of social-relatedness in this domain. By changing the way users cooperate in Pass The Ball we found that different practices emerged. We also found through examining use that people had different yet colliding experiences of cooperation and competition. Some were interested in competition and others not, but all were still informed about competition issues by their teammates. Social interaction was not without somewhat negative qualities such as obligation, conflict, and privacy concerns, which may or may not influence motivation. It seems important to move to more nuanced understandings of cooperative interaction in this area. This point should be seen in the light of the previous one, and our prior study of the use of consumer activity trackers [32] in which we found that the social use of trackers goes beyond the the use of ostensibly 'social' functions.

CONCLUSION

We have taken a research-through design approach to explore issues in activity tracking. We have followed a what-if question. As such, this work is discursive and has not set criteria for Pass The Ball to be a success or failure. In several senses the app was both success and failure. Pass The Ball was enjoyable for many players, led to communication and team interaction, and generally worked well over the two-week trial period. This shows there is room for creativity and the kind of rule-breaking discussed by [27] and subversion by [13] in the area of activity tracker based games. However, we must acknowledge that the game relied on us recruiting teams and coordinating a common start time. From a behaviour change perspective, Pass The Ball is also somewhat problematic. Speaking positively, the game mechanic encouraged people to think about and discuss not only their own activity, but also that of others. However, it did not often lead to players overtly encouraging others, it seemingly excluded those who did not have regular routines, and favoured those who were more active over those who perhaps needed to improve their activity levels. This situation might be improved (e.g. by including the tracker within a coach-led programme), but we can make no clear claim at this point in time that the design we describe has clear advantages over others.

In closing, we believe the activity tracker design space deserves wide exploration. There are many ways in personal activity tracking and relatedness can come together. Design oriented HCI has an important role to play in this investigation.

ACKNOWLEDGMENTS

We thank Marek Bell, Scott Sherwood and our colleagues in the Populations Programme (softwarepopulations.com). We also thank the anonymous reviewers. This research was funded by EPSRC (EP/J007617/1).

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