Using Fast Interaction to Create Intense Experiences

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ABSTRACT
Several emerging strands of HCI involve connecting physical exercise activity with digital interactive systems to create intense combined experiences, for example pervasive games, GPS based exercise games and 'exertion interfaces'. Many of these systems are mobile, used outside in public, whilst moving quickly through the environment. In this paper, we argue that the combination of moving fast and interacting with a digital system allows us to create a powerfully intense experience for participants, and that key to this is careful attention to the way in which movement is combined with digital content.

We study an interactive art experience in which a person runs whilst listening to poetry. Based on this study and other HCI research, we present a framework for mixing physical and interactive content, based on 3 dimensions, which describe ways that a movement activity may itself create intense experiences, followed by a set of tactics for combining intense movement and interactive content.

Author Keywords
Intensity, exertion, mobile, running, full body interaction.

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

General Terms
Design

INTRODUCTION
Connecting physical exercise activity to computer systems used for entertainment is increasingly common, with games such as Dance Dance Revolution [12], and Wii Fit [21] encouraging people to dance or do aerobics in to interact with a computer game. Further to this, capability of mobile platforms to detect position and speed has created a genre of 'pervasive games', games played on mobile devices whilst outside in a public place. Several of these involve fast movement, such as running to keep your heartbeat within a certain range [3], cycling around a city [25] and racing to beat other people's time around a course [17]. As well as games, exercise tools have been developed which use mobile technology to enhance exercise experience, for example by allowing runners to 'run together' in different places using devices connected by a network link [18], or to log exercise and allow people to compete with friends to do more exercise in a particular time period [7].

We argue that a key aim of interactive entertainment is to provide people with intense experiences, in the sense of a notable or unusual experience which provokes a strong reaction in the participant, and that encouraging moving fast while interacting ('fast interaction') is one possible way of intensifying the reaction of participants. Mueller et al's experiments [19] suggest that the combination of hard physical activity and interactive content in an 'exertion interface' creates a more intense experience for participants than a purely computer based experience. As well as the exertion of a physical activity, we argue that taking part in an activity outdoors in public further enhances the intensity of their experience. To explore this, we created a simple interactive movement activity, an art experience called 'I Seek the Nerves Under Your Skin' ('I Seek'), in which a poem alters based on the running of a participant. 'I Seek' is designed to create an intense experience, whilst being simple to understand and lightweight enough to deploy in a variety of settings. It is designed to elicit an interesting range of responses from participants and be compelling to them. We ran 'I Seek' with 82 participants at various artistic events, using a combination of data logging and interviews to explore people's experiences.

The key contribution of the paper is in two parts; firstly, we extract a set of dimensions from the study to describe ways in which exertion can be intense and mentally demanding:

i) Speed and level of exertion of the activity.

ii) Terrain and environment where the activity is taking place.

iii) Novelty of the activity and setting .

Secondly, we present a set of 8 tactics which take these dimensions into account. These tactics allow us to create extremely intense experiences by mixing fast physical movement with interactive content.

Whilst we wish to create very intense experiences, which may be scary for some participants, we usually do not want to expose participants to risks other than the normal risk of taking part in a physical activity. We finish this paper with

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a discussion of how we may ensure safety for participants in this kind of intense fast moving experience.

Figure 1. I Seek the Nerves Equipment

I SEEK THE NERVES UNDER YOUR SKIN

This section describes 'I Seek' both from a participant's perspective and also in terms of the technology that runs it, and the data that we gathered from the experience.

Experience

When a person takes part in 'I Seek', they are given a fluorescent jacket and a pair of headphones (Figure 1). When they put on the jacket and start to walk, a poem starts playing in the headphones (the poem used is 'Babelogue', by Patti Smith [29], a punk poem performed by her in a full on, spitting, swearing manner). If the person continues just to walk, the poem fades out. However, if they increase in speed, the poem continues playing for longer. Through the poem, the performer of the poem gets increasingly agitated, shouts louder and louder in the headphones, an audience to the poem starts a rhythmic clapping in the background and cheering, and everything gets a lot more intense. In order to hear the whole poem, the runner must accelerate continually, with the increase in intensity of their running mirroring the crescendo of the poem. If the runner does not go fast enough, the poem fades out gradually and restarts.

The runner must accelerate relatively quickly to reach a very fast sprinting pace by the end of the poem. This is very difficult, only a third of people managed to hear the full poem. Running this hard is a very intense experience, even for the short time required to hear the poem (99 seconds).

When the runner has had enough, they take off the jacket and headphones, and the equipment is immediately ready for another person to have a go. People take part in 'I Seek' outdoors, in public, running freely, wherever they like.

Design & Implementation

When designing 'I Seek the Nerves', we wanted a quick and reliable response to changes in running speed, and to be able to very quickly fit the equipment to people and take it off. We chose to base the system around a mobile phone (Nokia N95), using the built in accelerometer to detect speed – this is significantly faster to respond and gives a better indication of speed than the GPS on the phone. The phone is in the front pocket of the fluorescent jacket, with a wire coming out to the headphones.

The 'I Seek' software on the phone (written in Mobile Python [26]) runs throughout an event. In its idle state, it waits until it detects a certain threshold level of movement, and then starts the poem. While the poem is playing, the threshold level slowly increases. If the level of movement is below threshold, the poem begins to fade, until it has completely faded out, at which point the phone returns to idle state (and restarts if further movement occurs). Figure 2 shows how this threshold alters through the poem.

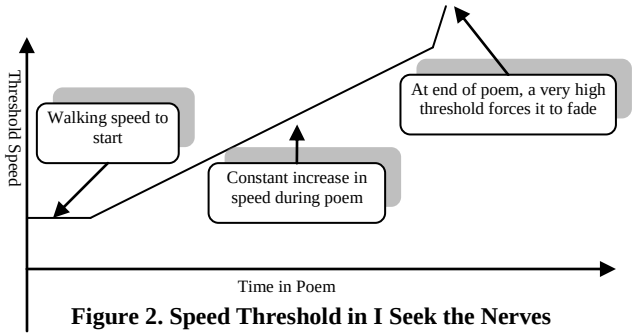

Figure 2. Speed Threshold in I Seek the Nerves

The current running speed is calculated using a scale based on the variance of the last .5 seconds of the total magnitude of the phone's built in accelerometer. This measurement was chosen as it is not affected by the angle of the phone. It also offers a more nuanced & fast reacting value than the step count value used in a pedometer, but is still easy to calculate. The relationship between actual speed and the speed value detected by the phone is roughly linear, but differs slightly between people, with longer legged people who take longer strides needing to go slightly faster to get the same detected speed. This is not a problem for the experience, as the change in threshold is far more than the difference between people. Essentially it just makes things slightly more even between short people and tall people.

Because there is no screen based interaction, the phone can be hidden in the pocket so it is not obvious. This both aims to stop people characterising the experience as a mobile phone game or similar, and also reduces the chance of the phones being stolen either by participants or onlookers. We also avoid the safety problems of looking down at screens whilst moving through cities which have caused danger to participants in several previous mobile experiences [1,3].

Running I Seek the Nerves

After initial testing with friends and colleagues, 'I Seek' has been run in three phases. Firstly, we ran a test of the system at an arts festival in Liverpool, UK. This was held in a run-down industrial area, on a dark and rainy winter night, with 30 participants. At this event, runners ran on small streets, and had to watch out for traffic, and deal with bad weather, potholes etc. We collected some observational data at this event, but primarily used it to fine tune the difficulty of the system and to get a rough idea of what people did with it.

The second event was at another art festival, held at Berkeley Art Museum, Berkeley, CA, with 41 participants. This event was run in the grounds of the museum, a complex modernist building, surrounded by ramps, terraces, and multiple different surfaces that runners had to negotiate. At this event we briefly interviewed all participants and collected log data from the system which describes how they ran. As all participants in this event ran in the same environment, much of the comparative data presented in the following sections is from this event.

We have three jackets, so up to three people were running at any one time at these events. At both the art events, as well as the runners, there were quite a few other bystanders. For the final phase of running 'I Seek', we wished to get a greater understanding of how it worked in different places, so we ran it individually for 11 participants, at the place of their choice, again following each run with an interview. Participants ran in a range of terrains, ranging from a tiny village, to a university campus, a town park, and a running event in a hilly country park.

We deliberately did not tell people what 'I Seek' was about, allowing them to make their own judgements as to what they felt it was for, and what the concept of the work was. This meant that people treated it very differently, with some seeing it as a game or challenge to be completed, others seeing it as a work of art to be explored, and a few seeing it more as a potential training tool for improving running. We were inspired in this by Sengers and Gaver's work on leaving interpretation up to users [27], which suggests that if no explicit interpretation is placed upon a system, either by telling people what it is for, or by implying it in the design, people will create their own story to describe the meaning and purpose of the system. The full body interaction and slightly odd social situation that the system is part of also helps in our aim to create an intuitive, visceral, intense experience, perhaps aiming for what Isbister & Höök describe as '*beyond the cognitive/rational level of the standard GUI interface*' [11].

Studying I Seek the Nerves

To study 'I Seek', we collected two forms of data about participants' experiences. Firstly, we logged the speed of the participants throughout the experience, along with data describing how far through the poem they were. Secondly, we interviewed participants afterwards, to get some idea of their subjective experience of 'I Seek'. We also collected demographic data from participants.

Figure 3 shows the speed log for one participant. The jagged lines show detected running speed, and the straight slowly rising lines show the threshold speed, dropping back close to zero each time the poem restarted and the runner had another try. By combining these graphs and the interviews, we are able to see what the system was doing and how people experienced it.

The scale shown is the raw speed estimate calculated by the device, which as mentioned previously has a roughly linear relationship to speed within a single participant, but does not compare across participants exactly – due to this the vertical scale is shown in device units, as it cannot be exactly converted into a real world unit. The jaggedness on the detected speed graphs is due to the uneven nature of the speed detected as people take steps while running – this is not a problem in the software as the fading out of the poem is quite gradual, essentially smoothing out the signal, meaning that if the person is generally above the threshold, they will still hear the poem, even if noise in the signal makes it sometimes go below threshold.

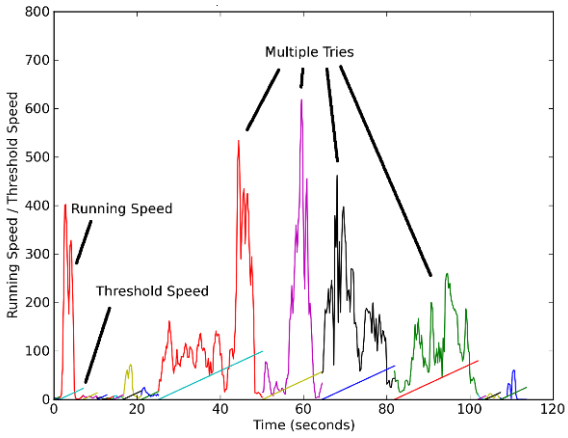

Figure 3. One Participant's Speed Graph

EXPERIENCES OF I SEEK THE NERVES

All participants who we interviewed reported that they enjoyed taking part in 'I Seek the Nerves'. Almost all participants had multiple tries at listening the poem, with a few trying it for over 10 minutes, a long time to take part in such a short experience (the poem is 99 seconds long).

People also reported that 'I Seek' was a very intense experience, as one member of a local running club said – "*yeah [I enjoyed it] … not what I'd call relaxing though, quite stressful*", "*that's like that movie Crank, or whatever it is, where you're going to die if you don't keep going faster*." In this section we describe the different elements that come together to make running in a public space whilst wearing the 'I Seek' equipment such an intense and exciting experience. This will be illustrated with quotes from participants and graphs showing how they ran during their experience of 'I Seek'.

'I Seek' was intense both for people who run regularly, and those who do not, although there were differences between runners and non runners. 15 of 52 participants in the last two experiments were runners (about a third).

The Innate Difficulty of Running Fast and Pacing

Only a third of the participants actually heard the full poem through to the end (13 of 41 runners at Berkeley, where all runners were running on similar terrain, so the difficulty level is roughly comparable). Making the experience difficult was a deliberate design choice, as we wished to mirror the fact that performing live poetry well is a challenging activity, by putting the participant in a challenging situation. A lot of this was just because it is very hard to run in the way that the experience demands.

Running fast is itself a difficult an intense thing to do. In 'I Seek', it is made particularly hard by the need to constantly increase speed. A big part of what makes this hard in 'I Seek' is that it only gives feedback when a person is going too slow, so people found it hard to pace themselves so that they did not run out of energy too quickly, one participant noticed this and actually altered their behavior to hear the end of the poem the next time - '*I think I at one point I probably accelerated more than I needed to, because at one point I was getting really out of breath and then I slowed down a bit and found it was still going, I think I made it harder*'. Interestingly, looking at the speed data, a lot of participants were able to reach the maximum speed, but were unable to keep it up. This inability to pace themselves was not just amongst non runners, because this is very different to how a runner would normally run – "*I found that really hard to do, because I think I'm used to running at a more consistent, constant pace, rather than running at a gradually building pace*". Several runners also likened the way in which 'I Seek' encourages an unexpected type of pacing to 'fartlek' or 'speed play' training, a form of running training which involves a mix of slow running interspersed with intense sprints of varying lengths. This is particularly true when a person cannot get to the end of the poem, as it will keep fading out and restarting, causing repeated cycles of slowing down and accelerating.

We can see pacing issues people had in the speed graphs, Figure 4 shows a runner who achieved a very fast speed, fast enough to complete the experience if they could keep it up, yet was unable to keep their speed up for long enough to hear the whole poem, and had to slow down. As well as poor pacing, quite a few people were just unable to reach the speed required by the system, so accelerated well to start with, then ran out of extra speed (Figure 5).

Interestingly, of those who completed the poem, there were also two distinct groups, mostly people paced themselves to beat the poem by gradual acceleration, but a few extremely fit people just went extremely fast for the full length of the poem and finished it (Figure 6). This was clearly hard, only 2 out of 41 participants at Berkeley managed it.

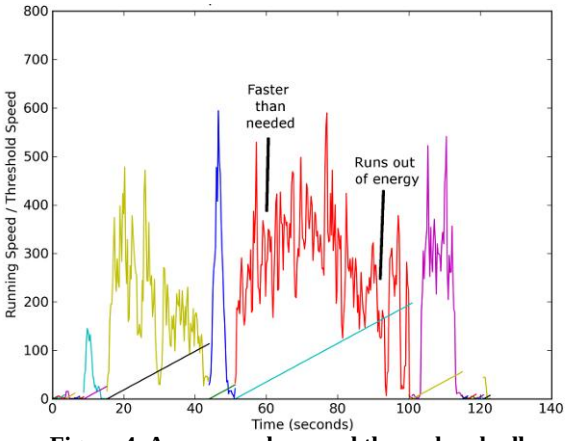

Figure 4. A runner who paced themselves badly

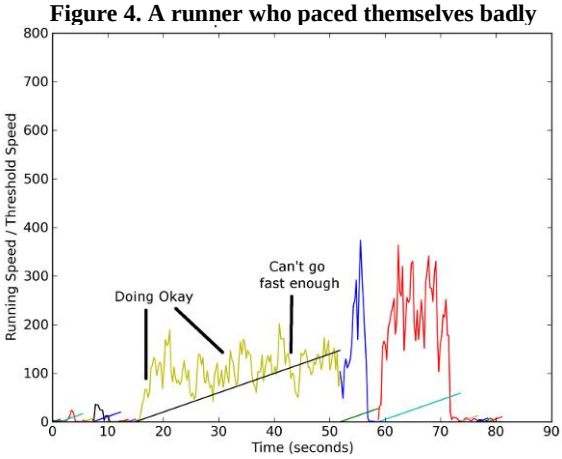

Figure 5. A participant who just couldn't go fast enough

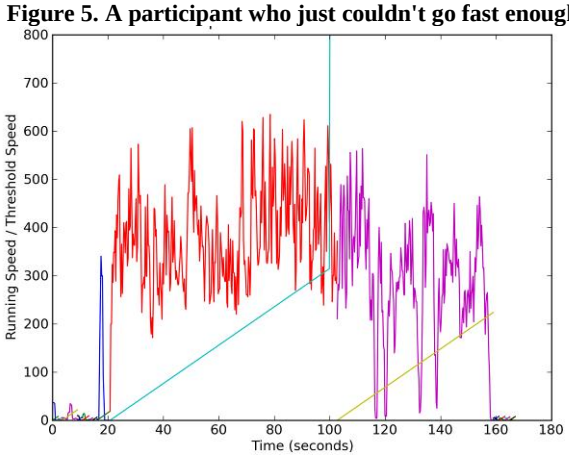

Figure 6. Constant fast running to complete the poem

Environment & Terrain

At Berkeley, the environment people were running in was complex, containing a lot of ramps, terraces, several different surfaces, such as grass, concrete and earth, and a lot of large metal pillars that people had to run around (Figure 7). It was also somewhat constrained, as it was at a ticketed event, so no one was allowed to run outside the grounds of the museum. This meant that whilst running, people had to deal with the challenges of dealing with their environment in addition to adjusting their speed and listening to the poem in their headphones. Just running in this environment was a complex task - "*I was going down*

the hill, I was going up the hill, ah, there were poles, I was navigating through the poles"; often people would come to a sudden halt due to the terrain (Figure 8 shows an example of a runner who got stopped by the terrain). Interestingly, several participants felt that dealing with the terrain was not a negative and actually added to the excitement and intensity of the experience – "*that actually added to the overall sensation, it added to the whole thing, if I was just running down a dirt road or something it'd be different, because it wouldn't be such a challenging environment*".

Figure 7. The complex running environment at Berkeley

One interesting element of terrain was that as well as slowing people down and getting in the way, participants reported making positive use of the terrain, for example one participant reported using a downhill to allow them to gain speed and get to the end of the poem -"*well, I saved myself up for the downhill bit, knowing it was going to get harder and I thought, well the downhill would give me a boost ... so I ran round in circles up there.*", this extra acceleration on the downhill can be seen in their speed graph (Figure 9).

Interestingly, the terrain seemed to be much less of a problem for people who regularly ran. Potentially this may be because they are used to taking account of terrain at high speed. In one example, one of the authors ran along with a runner, who was running through their local village, and observed the runner maintaining speed as they went round a blind corner, saw a car coming, timed their crossing of the road to avoid the car, and then ran past a group of people. Afterwards, when asked, the runner said that there was nothing in the terrain or the environment that they were running in that was in the way, and appeared unaware of the complex process of observations and avoidance that they had used to get through the area.

Regular runners also made use of their knowledge of the terrain they were running in and of how long it would take them to get somewhere in order to improve their chances - "*like if I could go down here, and then I could keep it going till the pub, and then down the really steep bit of hill when I was getting to the really tough bit*".

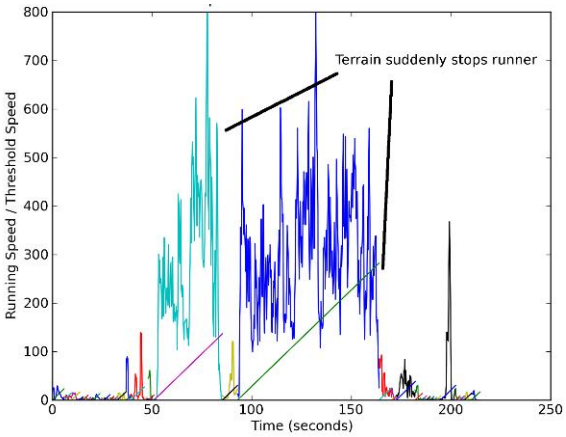

Figure 8. Runner stopped by the terrain

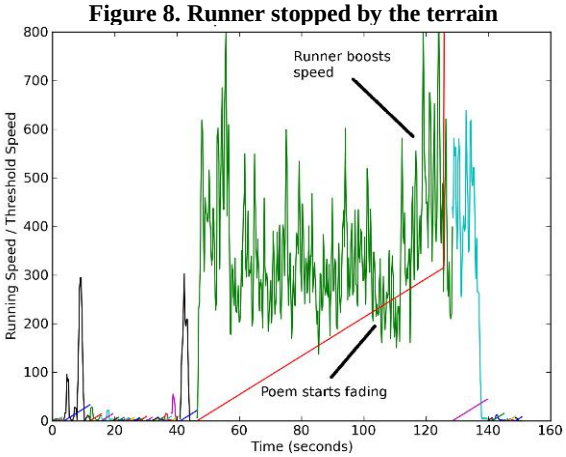

Figure 9. Using a downhill to boost speed

Other People

The design of 'I Seek' is what Reeves et al.[23] describe as a 'suspenseful' interface, with the effects of the interaction (the poem) being private to the participant, as they are only heard on their headphones, whilst the running with which the person interacts with the system is highly visible, made even more so by the fluorescent jackets and large headphones that are being worn. This is designed to act as an advertisement for the experience, making it very visible. It also appeared to make it more intense for people taking part – "*and er, and er.. because of this .. context .. you feel a little bit weird you know, running around, around the other people?*". Other people who were also doing the experience also had an effect on runners. For example a group of three who ran together found it reduced the oddness – "*I prefer going in a group, maybe because you feel a bit silly doing it, if you're in a group you don't feel so silly*". This group also found themselves competing to get as far through the poem as possible, which clearly added intensity to their shared experience.

Other people also made the experience more intense as they became obstacles to runners, slowing them down. This occurred both in terms of people physically getting in the way, as with objects in the terrain, but also politeness sometimes made people slow down when close to other people, meaning the poem stopped - "*[I] slow down when I*

pass by, and then it's like "oh wait, no, don't stop". One runner even described how they found themselves running differently because a friend chased them – "*somebody started to chase me, I had to run away from him, he started chasing me again, I had to run away again*".

Split Attention – Mixing Running and Poetry

Testing with a local running club, we discovered a significant minority of the runners completely refused to take part, as they did not believe it was 'right' to run with headphones on. One runner described this – "*I never wear headphones while running … I like to be aware of the environment*". This appeared not to be for safety, but more due to wanting to focus purely on the place in which they were running; there was a general disdain for 'joggers' who run wearing headphones without paying attention to where they are running. 'I Seek' deliberately splits this focus, forcing people to pay attention to both the environment in which they are running and the poem on their headphones. This leads to some interesting conflicts as the increasingly intense running requires more and more concentration.

For example, one runner described how whilst having multiple tries at completing the poem, they started trying to listen to the poem carefully, in order to be able to know exactly how far they had got through each time, however, the act of doing this made them lose concentration and run less well - "*I was thinking 'what was that they said then?' and I was listening a bit more carefully to what she was saying, and then I wasn't concentrating on my pace*".

Several runners described how they were unable to pay attention to the poem, particularly once they got running fast - "*[I heard] only the beginning, then after that, the, the err, the sort of the thudding of the running and the beating of the heart took over*". Others described how whilst they did not listen in enough detail to remember whole sentences, they still felt the poem added to the experience – "*I heard pieces of the poem, but I don't, I don't feel like I really heard a narrative, I heard a mood, there's an energy*"

The transition away from detailed listening, to focus more on the experience of running is also enhanced by the way in which running impinges on the audio – with the large headphones insulating people from other outside noise, the sound of their feet hitting the ground comes through their body and can be heard, mixing in with the rhythmic clapping in the background of the poetry performance - "*hearing my footfalls as like, bass* [in the headphones] *It was rhythmic, and I was trying err, you know, to keep up and do my thing*", "*I could really hear my feet, running, and that was really interesting to me, so the text became more background*". As described in the quote above, when doing hard exercise with your ears covered by headphones, you can hear your heart beating as blood is pumped faster around the body, which also becomes mixed in with the poetry to create an intense mix of replayed and live audio.

Control

The poetry track was deliberately chosen to fit in with the style of running encouraged by the work; this helped give people a feeling of control. For example, part way through the poem, an audience begins to clap rhythmically, slowly increasing in speed towards the end – a combination of this with the beat from their running led people to feel that they had more control of the soundtrack than the simple playback system provides, "*towards the end, there's quite a lot of beats, and you can actually, the faster you run, the faster the beat of the music is*". People reported surprise at being able to control the poem - "*I was thinking 'No, don't stop, don't stop, I wanna hear that', then 'oh, I can actually go faster'* ".

Whilst some participants simply tried to 'beat' the experience by getting to the end, many seemed to enjoy playing with the control afforded by their running. These two differing strategies are perhaps a key way in which the interpretation of the work is left up to runners themselves. We can see the two extremes of these approaches in the two graphs shown in Figure 10. The first runner started running, accelerated smoothly to finish, slowed to a stop, walked back and returned the equipment. In contrast the other runner put on the equipment, danced off whilst wearing it, and took more playful approach to the experience – "*I found myself running for the sake of running, like, running in, around the building, just, running in all kinds of weird places. … experimenting, to see if different movements would, err, get another kind of feedback. That was fun*".

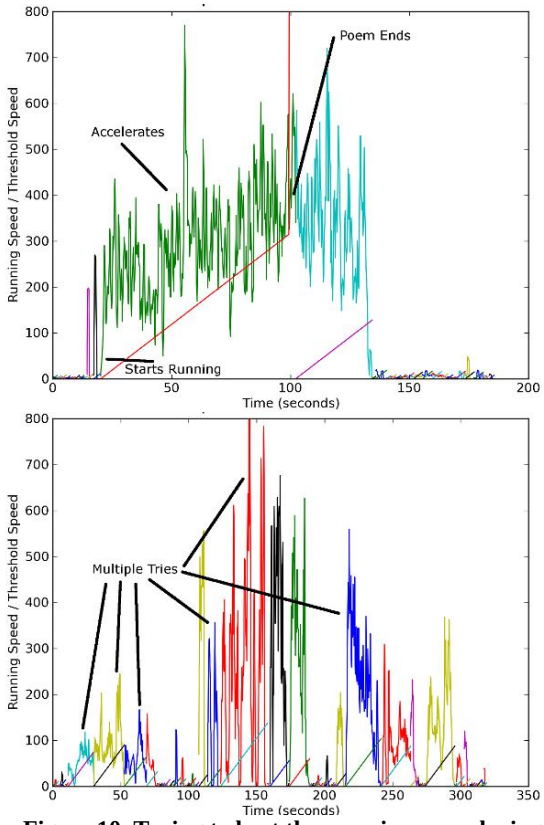

Figure 10. Trying to beat the experience vs playing

DISCUSSION: HOW TO CREATE INTENSE EXPERIENCES USING FAST INTERACTION

In this section, we discuss ways of using fast movement to create intense interactive experiences, based on the lessons learnt from deploying 'I Seek the Nerves'. From experience of running 'I Seek', we believe that key to this is the way extreme physical activity increases mental load on the participant, making them only focus on the essential aspects of the activity. Potentially this may create experiences in which the physical activity and the interactive content are seen as a single 'flow activity' [6], where people are unable to focus in on particular aspects of the situation such as running or interactive content, and instead become immersed in the experience as a single combined activity.

We first consider the ways in which physical activity may be intense, as a set of 'dimensions'; an increased difficulty in any of these dimensions creates intensity. The activity of running in 'I Seek' exploited aspects of all these dimensions to create an extremely intense experience.

The dimensions are followed by a set of tactics, which are ways to exploit the intensity of fast movement described by the dimensions in combination with interactive content to create intense interactive experiences.

Dimensions: How Fast Movement Can be Intense

Dimension 1: Exertion and Speed

The key thing that is used in 'I Seek the Nerves' to create intensity is making people run quickly. As we saw in people's experiences, accelerating and running at a high speed requires a large amount of concentration. The faster people go, the more they exert themselves, the more they have to focus on the running. The fact that exertion makes for more intense interaction is noted in previous work, for example in explorations of adding exercise to networked games to provide a more intense social experience [19], or adding real punching to a boxing game [10]. As the boxing game shows, exertion has multiple aspects – 'I Seek' focuses on very short, fast running, however there are also other ways in which exercise may be made intense, such as lifting heavy weights, performing exercises for an extended length of time, or performing difficult balance activities.

Dimension 2: Environment and Terrain

Where the physical activity takes place also has a major effect on how intense it feels. As we discussed above, obstacles (and people in the way) clearly make an experience require more focus on movement. When people are moving quickly, hills have much more impact on their movement than for slower experiences – something that has previously also been noted for cycling based experiences [25], where it was also argued that individual variations in fitness mean hills make a lot more difference, as the range of speeds possible are much greater. Downhills and uphills, as well as impacting the difficulty of exertion, may also change how much people have to focus, for example a downhill may allow you to run very fast, but that fast running may require far more concentration to avoid obstacles, Types of terrain also make a difference, for example in 'I Seek', people found it required more focus to run in woodland, with a lot underfoot, than in a flat field.

Weather and time of day also have a visceral effect – when 'I Seek' was run in Liverpool, it was a dark evening in a poorly lit area of the city, and there were several rain storms during the event. Even in the flat area in which it was run, people found the act of running to be an intense experience.

Bystanders are also part of the environment in which people move. Taking part in a fast experience around other people may well involve doing something visible to spectators which a person is not used to. This element of performing ones actions to bystanders can make an experience more intense – particularly when a strategy of exposing the interface to spectators is used [23]. Bystanders may also be in vehicles, or also running, which may make the situation require more concentration. Clearly putting people into situations with traffic requires careful design; for example in the cycling game Rider Spoke [25], riders were only allowed to interact with the computer system when stopped.

Because of the many challenges of real world outdoor environments, we would argue that outdoor experiences have the potential to add a new dimension of intensity compared to purely exertion based experiences using treadmills or other stationary equipment.

Dimension 3: Novelty of the Activity and Setting

People for whom a physical activity is a more novel skill will find it more intense compared to those who have trained extensively. For example at the various events where 'I Seek' was run, we encountered a large variety of running ability and skill. For some people, running was a regular activity, for others it was something they were not accustomed to at all. John Hockey [9] discusses the way in which skilled regular runners have a very rich knowledge of terrain in which they run, and analyse and respond to it quickly as they run; this domain knowledge appeared in 'I Seek' to make quite a difference to how much of their attention people have to give over to their running.

Hockey's work also highlights how much people know about the areas in which they run regularly – this can be seen in the example of the runner discussed above, who managed to navigate through a complex junction and a traffic situation in their local village, whilst still paying attention to their overall strategy of using the hilly terrain to their advantage. This made a big difference when running 'I Seek' with people in places familiar to them, compared to the events in Berkeley and Liverpool, where most people were running in areas that they had never visited before.

Tactics for Matching Physical & Interactive Experiences

In this section, we present 8 tactics which allow us to utilize the intensity created by physical exertion (and described by the dimensions above) within an interactive experience.

Tactic 1: Overload attention

People only have a limited ability to process information. This means that if people perform multiple tasks simultaneously, they are potentially distracted from one task by another task which is taking more of their attention. Overloading people's attention is typically seen as a problem in HCI. For example, avoiding computer interfaces distracting people away from the visual task of driving has been a particular focus of HCI research, due to the obvious safety implications [22]. Clearly we do not want to endanger participants by taking their mind off their running. However, the inverse, making people perform intense physical activity and making it hard for them to pay attention to interactive content may be a useful strategy when trying to create intensity in an interactive experience. For example, runners in 'I Seek' reported how once they ran fast, they could not entirely concentrate on the poem. Some suggested that this added to the experience, with the poem being heard as more of a 'mood' underlying their experience, rather than them consciously listening to it.

Tactic 2: Exploit Partial Attention

The way in which people are distracted from the audio by the running creates a situation where they can only pay partial attention to the audio. As shown in 'I Seek', creating this kind of partial attention has the potential to make audio or other outputs less clear, leading to people interpreting it in interesting ways, such as the person who felt that the speed of the music was directly reacting to them in 'I Seek', when in fact it was just the natural progression through the poem coupled with their acceleration in order to be able to hear it. We would argue that the knowledge that people were unable to fully listen to the poem made the experience more intense – ie. Running fast whilst not quite managing to listen to poetry is a more intense experience than either just running fast or listening to poetry while stopped.

Tactic 3: Create Transitions in Attention

The transition from a state in which the person is fully able to pay attention into partial attention is also interesting, as it creates the feeling of loss of ability to handle all the stimuli that are being thrown at the participant in an experience. This transition could be used when planning an experience by deliberately exploiting factors such as increased speed (Dimension 1), orchestrating experiences so that people arrive at hills or other terrain features at the same time as digital content which we wish to be obscured (Dimension 2), or making interactive content less distinct by moving the experience out of people's comfort zone, for example by making them increasingly lost or encouraging them to perform increasingly complex movements (Dimension 3).

Tactic 4: Match interactive and physical content

Mueller et al. [19] describe how simply taking an existing sport and making it an interactive game does not really work, and how physical 'exertion interfaces' and the games or experiences they are used in must be designed to work together. For example, in 'I Seek', care was taken choosing the short, explosively intense poem to fit with the relatively short burst of intense running required by the system, and fitting the threshold used in the system to the timing of the poem. This was not just about the matching the tempo of the poem with the running, but also about finding a poem that was performed in an increasingly loud and intense manner, so that in the most intense points of the running, the poem was also extremely intense in tempo, volume and the general agitation of the person performing it.

Deliberate matching between content and movement in 'I Seek the Nerves' is purely about speed and exertion level (Dimension 1), as that is all the experience is able to measure. The way in which terrain (Dimension 2) affects choice of content in has been discussed in previous work relating to cycling based audio experiences [25], where designers may wish audio placed on uphills (when people are working hard, but moving slowly) to be very different to that placed on downhills (where people are not pushing themselves, but are moving quickly). Also, in cycling (or other exercise) different fitnesses of rider can have a very different experience [25]. This means that interactive content may need to adapt itself to match the skill, experience and fitness people taking part (Dimension 3). 'I Seek' sidesteps this slightly, by deliberately being a difficult experience, which it is expected unfit or poorly skilled people will not be able to finish, rather than attempting to adapt for different fitness levels.

Tactic 5: Exploit Sensory Overlaps

The matching between poem and running is encouraged by the way that people's senses are overloaded not just visually, but also by the way sounds created by the system and sounds generated by people's running overlap. The matching between interactive and physical content is not just about matching the mood and tempo of the content to the running, it is also enhanced by the way in which the beat of the person's feet as they run mixes in with the poem, making a combined audio soundtrack which feels more intense to participants than purely listening to the audio track alone. Interestingly, sports science research has demonstrated that people actually run significantly faster if audio they are listening to is in synchronization with their running [28], meaning that this kind of matching may in itself encourage people to push themselves harder, thus making their experience more intense.

Tactic 6: Encourage Intense Physical Behavior with Content

In order for the tactics described here to work, we must have some way of encouraging people to push themselves to reach a desired level of physical intensity. In 'I Seek', this is done by using a very basic mapping, which requires a constantly increasing intensity of running in order to hear the content at all. In combination with compelling content, which people wish to engage with, this very simple method of removing the content unless someone performs the

desired level of exertion is very effective. Several other 'exertion interface' [19] based systems use biological measures as a proxy for exercise intensity, such as measuring the heart rate of participants [3], and again reward people for keeping these measures within particular ranges. A particularly interesting system is 'Pulse Masters Biathlon' [20], which measures two aspects of fitness, first a cross country skiing minigame which rewards intense effort and high heart rates, then a shooting minigame, played directly after the skiing game, where it is easier to aim if one has a lower heart rate, rewarding ability to recover from exercise. As well measuring how hard or fast physical activity is (Dimension 1), we can also consider the other two dimensions that make things intense. Terrain (Dimension 2) can make a big difference, potentially systems can take into account the particular terrain people are running over, as is done in the sport of orienteering, where higher points are awarded for crossing more rough terrain, or going up large hills. As well as purely physical terrain, the particular social environment in which an experience is run can also be rewarded – for example the drug smuggling game Blowtooth [14] rewards players for (pretending to) smuggle drugs through real airport security zones, something which clearly makes the game more intense than if it were played in a less charged environment or purely online. Similarly, Rider Spoke [25], creates rewarding experiences for those who are willing to navigate complex city traffic on a bicycle.

Tactic 7: Encourage Performative Actions

The visible and unexpected nature of actions in 'I Seek' also encourages an intense experience, in that people were rewarded for running fast and effectively performing in front of other people (Dimension 2). Running was particularly unexpected at busy art festivals. Other projects have also used large, visible movements such as spell casting [1] to create increased intensity. It may also be useful when aiming to design this kind of performative gesture and encourage intensity by making people do things that feel out of the ordinary, to deliberately work outside HCI guidelines for what gestures are felt to be normal or socially acceptable when performed in public [24].

Tactic 8: Encourage Unexpected Actions

With 'I Seek', we created something which even for runners was an odd experience, which encouraged them to move outside their accustomed running styles (Dimension 3). We also encouraged a lot of people to run in places where they were unlikely to have run before, and non runners to run fast, something which many had not done since childhood. Rewarding people for moving outside their comfort zone is a useful tactic, and has been used in other experiences, for example the pervasive game 'Uncle Roy All Around You' began by asking people to leave their possessions behind, including maps, which intensified the experience - *"Players were asked to leave all possessions at the ICA so I had no watch, mobile or map. This worried me because I didn't know the area and when directed to Pall Mall or other places, I had no idea where these were and unfortunately, the people I asked for directions got it wrong resulting in me heading in the wrong direction. This, however, didn't detract from the experience."*[2]. This deliberate encouragement and rewarding of disorientation and doing things that are out of the ordinary may be a very useful way of creating intensity even when people are not being made to move fast.

SAFE MIXING OF INTERACTIVITY AND MOVEMENT

Whilst we wish to create intense, often dark and perhaps scary experiences, when creating experiences in which people move fast it is important to keep participants alive. This is particularly true when people mix with traffic (such as in cycling [25] or car based experiences [4,8]), or encounter challenging terrain (such as interactive climbing walls [13]). We need to ensure that when we push people to a point where they are unable to concentrate on everything that is happening to them, they are still able to pay attention to things likely to harm them. Key to this in 'I Seek the Nerves' is the purely audio interface, as when people are moving fast, vision is a key sense that allows them to navigate and avoid danger (a similar approach has been discussed in car based computing [5]). We also performed site surveys on locations before we ran 'I Seek', to check whether there was any danger nearby that we needed to warn participants about. One must also be careful about health when encouraging people to push themselves – 'I Seek' is deliberately short, and also does not penalize stopping and resting, or multiple tries and is unlikely to cause any medical problems, but in longer experiences if care is not taken to avoid pushing people too hard for too long, there is a potential health risk (e.g. marathon running can increase risk of heart attacks [16]).

When considering safety, we need to take into account all three dimensions which may all make a difference. For example how hard people are asked to run (Dimension 1: Speed and Exertion) may be less important if the people in question are experienced runners (Dimension 3:Novelty). Safety may also depend on where people are asked to run (Dimension 2:Environment and Terrain), and how well they know that particular environment, and how skilled a runner they are (Dimension 3: Novelty).

CONCLUSIONS

In this paper, we have described the study of a mobile interactive experience combining poetry with running. This was a very intense experience for people taking part. By interviewing participants and collecting logs of their running, we have been able to explore the factors which make this an intense experience.

Based on the study, we described ways in which physical activity produces an intense experience, and a set of tactics for integrating hard physical activity within interactive experiences in order to create very intense experiences.

These dimensions and tactics may be particularly useful to those developing systems such as games involving fast movement or extreme physical exertion (eg. [3, 10,13,20,25]), and in making novel exercise support systems (eg. [7,18,19]) more compelling for users. One interesting point to make, is that whilst here we measure physical activity by measuring speed, a growing number of projects use biological sensing as a measure of physical exertion. Our tactics are also applicable in such a situation, but use of bio-sensing to create intense experiences may also create further interesting feedback loops between participant and system, as the biological signals are not purely representative of physical activity, they are also affected by the stress of an intense experience. We explore an example of combined physical and emotional feedback in our research into breathing controlled thrill rides [15].

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