Designing to Distract: Can Interactive Technologies Reduce Visitor Anxiety in a Children's Hospital Setting?

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Many public buildings are entered through reception areas, intended for visitors to sit and wait in to be met. A concern is how to make visitors feel welcome while in transit. Hospitals, medical centres and other healthcare organisations are a special case where the challenge is to enable patients and families feel less anxious when waiting. One approach has been to design for distraction – where displays, surfaces and interactive installations are created to draw visitor's attention away from their immediate thoughts. However, little is known as to how people respond to such interventions. We present the findings of an ethnographic study that examined the social and psychological effects of using distraction as a desgn principle in a children's hospital reception area. We discuss the challenges of designing to distract, in relation to how it can be combined with other architectural and HCI ones, when developing new human-building interfaces.

CCS Concepts: • Human-centered computing; Field Studies

Additional keywords and phrases: children's hospital, distraction principle; Interactive floor displays; public displays; reception area

1 INTRODUCTION

The reception area of a hospital is the arrival place for patients and their families, as well as a busy place for staff and contractors entering and exiting the building. It is typically designed as a place that visitors can sit down in while waiting for their appointment. From here, they obtain their first impression of the place [36]. It is often the case, however, that patients and their families are in a heightened state of arousal [45]; experiencing negative emotions, while nervously waiting to hear the results of their tests and/or the latest prognosis from their doctor. Such a state of anxiety can be exacerbated by entering an unfamiliar building where they do not belong.

A problem confronting architects and interior designers, therefore, is how to build a physical environment that can help reduce visitor anxiety. Considerable effort often goes into designing waiting spaces to make them welcoming and comfortable. Artwork, water coolers and reading material are often provided to make visitors feel at ease while toys and play areas are provided specifically to give children something to do. Recently, some hospitals have started deploying technologies (e.g. flat TV monitors, interactive wall displays) in their reception areas to provide visitors with something to preoccupy themselves with [37, 51]. The design rationale for their inclusion is that they can provide a form of distraction, that can help shift visitor's attention away from the anxiety of waiting and not knowing, to something momentarily more pleasant [43].

One of the problems of adding new technology into hospital reception areas, however, is that they can be a hygiene hazard. Surfaces need to be kept clean in hospitals in order to reduce the risk of cross-contamination, especially those that are commonly touched, such as door handles and computer touch screens. Dust needs to be prevented from accumulating on floors, furniture and other interior spaces that visitors come into contact with, such as shelving. Those responsible for procuring new technology, therefore, have to be mindful of the surfaces they create and the input devices that patients will come into contact with when operating or interacting with them [38]. Technologies, like tablets and tangibles, that require users to touch them, are likely to present higher risks than TV monitors that are automatically switched on or wall/floor displays that are interacted with without touching, i.e. mid-air gesture or foot input.

While it is relatively easy to gauge the potential contamination risks associated with a given technology, it is less clear how they can be evaluated in terms of their contribution to reducing visitor anxiety. Little is known about how effective different kinds of technological interventions are at engaging people in the context of a

hospital setting. To learn more about how visitors approach, use and respond to technologies, that have been specifically designed to reduce visitor anxiety, we conducted an ethnographic study of the reception area at Great Ormond Street Hospital (GOSH). This is one of the largest paediatric hospitals in Europe with more than 250,000 patients, both from across the country and also from overseas, visiting it every year [19]. The hospital has gone through several renovation programmes to upgrade the Victorian buildings, including, recently, refurbishing the reception area. Much thought has gone into how to design the interior space, especially for sick children and their families, to make it easy to navigate, find information, and feel comfortable. A central concern has been the provision and placement of technology that can occupy visitor's time while waiting. The focus of our research was on how the various features that were designed and implemented in the latest renovation were able to distract visitors, through engaging or informing them.

We report here the findings of our study. Interviews with GOSH staff and observations of the space showed how contextual factors and physical affordances affected the extent to which the various technologies were used. We present a conceptual framework based on our findings of how visitors approach together and engage with an interactive floor display in a public setting. Finally, we discuss the value of including distraction as a human-building interaction design principle together with the challenges of measuring its impact on anxiety.

2 BACKGROUND

2.1 Anxiety when visiting hospitals

Adjusting to an unfamiliar environment is an important part of visiting a hospital for patients and their families [47]. In particular, hospital waiting areas are places of uncertainty where patients first enter the hospital, not knowing what news lies ahead and often experiencing anxiety while waiting for their medical consultation. This uncertain time is often exacerbated by not knowing how long they will have to wait before being seen by a GP, clinician or consultant. Anxiety is common, especially knowing that they are not in control of the situation [31]. Many people have negative feelings towards hospitals when contemplating what happens in them, such as fear of suffering and death [10]. This fearful perception makes people not only feel threatened when having to go to hospital but also vulnerable [51]. Visiting a hospital building, therefore, can create additional stress that adds to the worry and anxiety accompanying having a physical illness in the first place [29, 48]. Having to cope with a strange environment can directly act on a stressor [44], and in doing so, deplete the coping resources which are necessary for dealing with a stressful situation. While the environmental features of a hospital might not be the actual source of a person's stress, they can *"exacerbate or attenuate the negative impact of some co-occurring psychosocial stress"* [29].

One way hospitals have tried to reduce heightened patient anxiety is through 'softening' the waiting area to make it feel more comfortable [14,15, 26, 30, 36]. However, they also have to adhere to strict building design criteria that are specific to hospital settings, including hygiene, cleanliness and accessibility. Trying to abide by all of the requirements can be difficult and sometimes compromises have to be made. For example, the emphasis on keeping hospitals infection free can be at the expense of overlooking psychological aspects. As Ulrich et al [46] note, hospitals *"often produces facilities that are functionally effective but psychologically 'hard'"*. Hence, a challenge is being able to satisfy all the necessary functional requirements as well as making visitors feel comfortable.

2.2 Distraction as a human-building design principle

A concept that has been applied to building spaces, where it is known that visitors are likely to have heightened anxiety, is positive distraction. By this is meant *"an environmental feature that elicits positive feelings and holds attention without taxing or stressing the individual, thereby blocking worrisome thoughts*" [Ulrich, 1991, p. 102]. It has been proposed that a pleasant physical environment that is able to distract a person's attention from focusing on their anxiety [5] can improve their mental state of wellbeing [28, 38, 42, 44, 46]. According to prior research, the notion is not only helpful for reducing anxiety, fatigue, stress and pain but can also decrease

perceived waiting time and contribute to improving the overall visiting experience in the hospital. Positive distraction is especially important to consider in paediatric waiting areas because of the challenge of holding children's attention for indefinite periods [42].

A study comparing two different paediatric waiting spaces found that calm behaviour and attention were increased by positive distraction in both places [44]. However, the degree of influence varied depending on the situation (e.g., different medical conditions of patients). The findings suggest that it is important to understand the environmental context before deciding where to place distractions in a hospital setting [50]. It is also important to consider that distraction can work both ways: it can have a positive and negative effect and in doing so can decrease or increase anxiety, respectively. For example, in a family home setting, we found that the deployment of augmented reality technology was able to positively distract pre-school age fussy eaters, from their dislike of green vegetables but also negatively distract their siblings. The technology worked by removing the fussy eater's focal attention from the peas on their plate and instead switching their attention to observing and playing with animated lights projected onto their dinner plate [18]. Instead of simply refusing to eat the peas – as they normally do - the augmentation encouraged the young children to view the plate of food in a new way, and in doing so, shift their focus from eating as a primary activity. However, when used during a family mealtime setting, where parents and siblings also took part in encouraging the fussy child to eat their peas, the new technology sometimes triggered a negative response. Namely, the siblings at times became jealous and competitive. Hence, the context in which the technology augmentation took place was found to have a positive effect on the fussy eater but also impact on the social dynamics of the family.

Consideration is needed, therefore, when choosing a technology, lighting, colour scheme, or furniture, as to whether it will calm or over stimulate the intended inhabitants of the building space. Interactive technologies designed for children carry the risk that they can negatively distract. Computer games, for example, may over stimulate, resulting in increased anxiety. Overly complex displays can also lead to frustration or non-use especially in public spaces. A key design question, therefore, is whether and how public displays can distract anxious patients and their families.

2.3 Architectural design of public spaces in hospitals

Architects increasingly consider the social and psychological effects of design features in physical environments, and, how the physical environment affects a visitor's psychological state of wellbeing. They often adopt a theme or particular style for the interior design, for example, a modern look [29], as a way of making a space comfortable and agreeable. Research has shown that the type of decoration, furnishings and physical layout can increase social interaction while also reducing negative emotions, such as anxiety [3, 23, 24, 45]. It has also been suggested that the more attractive the physical environment is, the more likely people will respond positively to it [11]. Being attractive to look at is thought to distract patients and, in doing so, reduce their stress levels. For example, a study comparing a modern "nouveau" design with a more traditionally designed space showed that stress levels, detected by participants, decreased in the modern waiting area while increased for the traditional one [29].

Colour and lighting are also commonly used to make a space appear attractive. The use of certain colours, like shades of mid-blue, can have a calming effect on someone. Conversely, large areas of red, used for walls or floor covering, can over stimulate anxious patients. It has been found that warm colours are often used in hospital waiting rooms, such as oranges and yellows, for walls, furnishings and seating to brighten up a space and to make it feel inviting [52]. Artworks, comprising subdued patterns or designs, are also often used rather than busy artwork which can over-stimulate. TV monitors and video wall displays are now commonly deployed as distractions in the healthcare environment [42, 44], helping to configure the temporal and spatial layout of the spaces [32]. However, they are a one directional medium [27], requiring the sound being turned off so as not to disturb others who are not watching them.

Paediatric hospitals require even more consideration than general hospitals to take into account the specialised needs of sick children, especially their emotional and physical development [37]. Much attention has been given to designing various areas, like wards, reception areas and play areas, to make children feel more at

ease and comfortable. A common architectural approach is to tap into the nature of childhood that encapsulates innovation, play and fantasy [20]. Underwater or sea environments are popular as an interior design theme [13]. Other requirements include the need for universal accessibility, the importance of fitting into the specific constraints of the space and the proximity of the user to the interactive display [6]. An additional concern is that young patients are usually accompanied by their parents and siblings. As the patients visit the hospital with relatively more companions than in the case of adult patients, the experience of the other family members in the hospital is also an important consideration [40].

Walls are often covered in child-friendly murals, while seats and wheelchairs are brightly coloured and child-sized. Reception areas are also increasingly being fitted out with play areas with customized interactive technologies. For example, ZOOTOPIA was designed as a tangible toy set to enable children in hospitals to see animals in live streaming videos by playing with them using physical tokens. The rationale for the design was to encourage them to talk with others when playing the game, so as to reduce social and emotional difficulties [1]. Another play area developed specifically for the Royal London's Children Hospital has a customized wall-sized display that shows an image of the visitor superimposed on the backdrop. The goal is to make children feel as if they are actually in the virtual environment and want to play with the other virtual characters and objects depicted. Nemours Alfred I duPont Hospital for Children has set up a similar wall-sized interactive display, called the Discovery Zone [36]. Magical creatures and blooming plants appear on the display in response to children moving in front of it. Many of these reception area play spaces, however, have yet to be evaluated.

2.4 HCI research and public displays

Much of the HCI research evaluating public displays has focussed on whether they can attract passers-by. A focus is whether people notice them when walking passed, do they then approach and interact with them – or do they simply walk on? Various factors have been investigated, such as how attractive they are, the level of buy-in to use them, and whether they are perceived to be socially embarrassing to use [12, 34, 39]. General guidance arising from this line of research suggests that public interactive displays should be visible from afar so that people can initially watch others using them, and on this basis decide whether to take part themselves. They also need to be reassured that they can easily leave if they feel uncomfortable at any point without making a fool of themselves [9].

A number of novel interactive technologies situated in public spaces designed to encourage public engagement and social interaction have been evaluated. These include large media projections, such as Façade [16], and tangible interactive boxes to encourage people to voice their opinions in public, such as Voxbox and SmallTalk [17]. An outcome from the evaluation studies has been the development of conceptual frameworks and design guidance (e.g., 9, 16, 33, 49), intended to inspire and guide other researchers. The frameworks have largely focussed on temporal and spatial aspects, describing when and how passers-by first notice a display, to whether they move nearer towards it and if so, do they interact directly with it. Brignull and Rogers's framework [2003], for example, identified three different spaces and two transitions phases. They also discuss the affordances that can encourage engagement together with the bottlenecks that can discourage it.

There has been less research, however, on how to attract people who have gone to a public space as a destination to *meet* someone rather than those *passing* through a public space. Waiting versus moving through is likely to have different demands on someone. Firstly, there is the concern that in a hospital reception area, visitors may not even notice an interactive technology because they are in a heightened state of anxiety. Secondly, there is the possibility that those who begin interacting with a technology in the hospital setting could become over-excited, which is not a desirable state. Thirdly, because reception areas are often designed as confined spaces, it raises the question of whether the kind of interaction being designed for is socially acceptable for others waiting in the same space, as the effect on them could be negatively distracting (e.g., too noisy). This was found to be the case when an interactive public installation, intended to trigger social interactions, was deployed at a bus stop actually increased anxiety among those people waiting for a bus. Some even left the bus stop, annoyed by the noise made by those using the public device [4].

In sum, it is likely that there are different challenges when designing for and placing public displays in a hospital reception area compared with other public places. The goal of our research was to investigate how public technologies are approaches and interacted with in such a setting. Furthermore, while there are now increasing numbers of interactive wall and floor displays being implemented in hospitals, there have been few empirical studies assessing whether they achieve what they were designed for. Little is known as to how effective they are at distracting children and their families from the anxieties they experience when entering a hospital. The aim of the research reported here is twofold: firstly, to examine from a user perspective how and whether customized interactive technology can distract children and their families in a reception space and, secondly, from a design perspective how the social-psychological principle of distraction works when also needing to satisfy multiple functional requirements (e.g. hygiene, safety, aesthetics) in hospital settings.

3 THE REFURBISHMENT AT GREAT ORMOND STREET HOSPITAL (GOSH)

3.1 The architect's plans

Several years of planning were involved in the redevelopment of the GOSH reception area. During the initial phases, patients, families and carers' opinions were all taken into account. Of particular concern was how to accommodate a diversity of visitors, often comprising whole families, including grandparents, siblings and parents, who have travelled a long way to get there. Many of the patients arrive in wheelchairs, use sticks or other prosthetic devices – adding a further set of needs to consider. The design for the refurbishment went through many stages, involving many levels of approval and feedback. Every detail was considered and documented to be compliant with fire, health, environmental and safety regulations.

Several user-centered building design principles were outlined in the initial stages, including the entrance design should be child and family friendly to reflect the needs of patients with an age range from birth to adolescence. Another requirement was that the entrance should be able to promote a warm and friendly impression whilst not being overwhelming or noisy. Other user requirements included the space should maintain the privacy and dignity of the patient and family; promoting confidentiality and enabling a safe environment for the patient and their family.

After much consultation between the architects, the clinicans and patient representatives, a novel interior design was proposed. One of the initial architect's conceptual design is presented in Fig. 1. As part of this design, several ideas were proposed to create child-friendly spaces. A core rationale was to make the reception area fun and vibrant for all visitors. The challenge this raised was how to design a space that could accommodate all ages without being too childish or adult-like. In the end, a nautical theme was chosen for the area, where the reception desk area was shaped like a ship, located in the centre of the space. The design rationale was that it could be accessed from all sides rather than just the front – as is the case with conventional reception desks. One wall was also shaped like a wave covered with an attractive ocean mural.

A number of interactive technology spaces were also envisioned for the space that could accommodate children of different ages. These included an area for toddlers with a projected interactive floor display, a play area for pre-school children with iPads and X-box (aged 3-4), and an animated fish display next to the reception desk. However, only the ineractive floor display made it from the initial plans to the final design. The initial plans required alteration based on additional space requirements and compliance with the other criteria, especially infection-control.

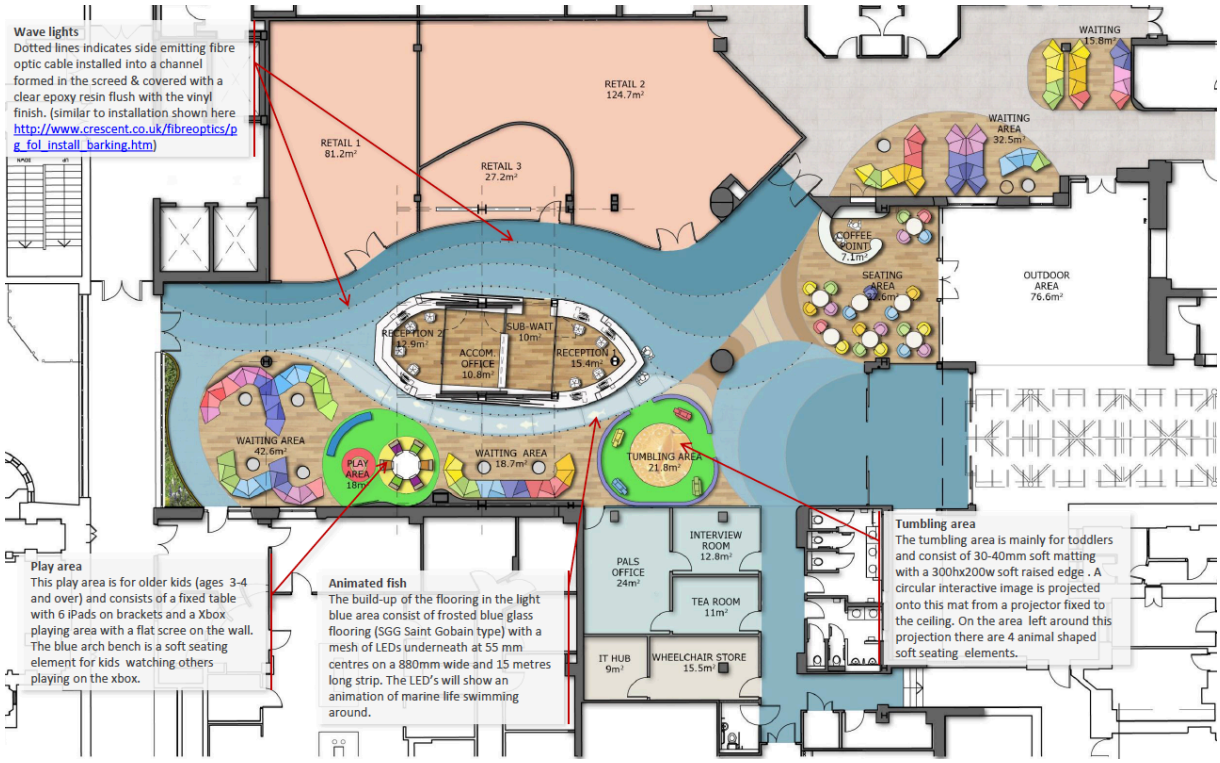

Fig. 1. Architect's initial design for the refurbished reception area at GOSH.

In addition, a flat TV monitor and two information kiosks were situated at different locations in the reception area. The original design of the information kiosks was to provide a PeterPan themed interface that visitors could interact with and then download a customized navigation guide onto their smartphones. The kiosk plus phone model were intended to provide a fun way for families to follow instructions to reach their desired destination in the hospital, by using state of the art indoor positioning technology. However, this idea of a distributed navigation system proved to be too complex to implement at the time, as the available technology was not reliable or robust enough to support it. Expecting families to download an app onto their smartphones was also asking too much. Instead, a more conventional interactive map display was developed, but still using the Peter Pan theme, that would simply run as a stand-alone kiosk.

3.2 The final design and deployment

Fig. 2 shows photos of the final design and the location of the marine wall, the interactive pond, the different kinds of seating and the location of the information kiosks. The fish pond was programmed to move virtual fish around in response to someone standing on it by changing their direction as if moving away from the person. At the same time, waves appear to rise at the edges of the pond, creating the visual effect of rippling and lapping water. The flat TV monitor was placed on a wall adjacent to the pharmacy and was set to show children's programmes on a loop.

Fig. 2. The actual designed space for the reception area at GOSH: the sea mural wall (top left); the interactive floor display with adjoining brightly coloured stools (top right and middle left); the projected fish pond display (middle right), the curved soft seating next to the reception desk (bottom left) and the information kiosks (bottom right).

4 THE ETHNOGRAPHIC STUDY OF THE GOSH RECEPTION AREA

A two-month study was conducted where observations were made of how patients, their families, visitors and staff approached and used different areas of the reception space at GOSH. Because of ethical restrictions, it was not possible to talk to patients and their families directly in the space or to contact them. In particular, given the patient's personal situation, it was considered unethical to measure their level of anxiety – as this might have

exacerbated their current emotional state. Hence, we opted for inferring their state of wellbeing through non-identifiable observations and proxy interviews with staff and volunteers who were working in the area.

In total, four volunteers helping out in the reception area and six staff working at GOSH were interviewed. The interviews were transcribed and read repetitively for familiarization, before being coded for topics, using thematic analysis. These included: their perceptions of how the space was used, what technology or design feature worked and what did not. The behaviour of the patients and families in the entrance space was observed and recorded through hand sketching their paths, noting how long they spent in an area. The flow of human traffic in the reception area was then analysed in terms of: how people found directions; their interactions with staff or volunteers, how visitors spent their time when waiting and their usage of the signage. The focus was on how the virtual pond, the TV display and the information kiosks were used.

Observations were made over several weeks. 204 groups (358 people in total) were recorded visiting the reception area. The number of people visiting or sitting in a particular space was noted alongside their demographic (parent, child, clinican, volunteer). An estimate of the ages of the children was recorded. The trajectories of the visitor's movements were sketched alongside hand written notes of what they did.

5 FINDINGS

A main finding from the observations was that the interactive pond acted as a positive distraction for children of all ages. In addition, families chose it as their preferred place to sit when first entering the reception area. In contrast, visitors waiting in the pharmacy area for their prescriptions appeared to be much more subdued and negatively distracted.

5.1 Interviews

Initially, the interviewees all pointed out how the reception area is a busy place serving multiple functions in the same space: as an arrival point, a transit point, a place for out patients for collecting their medication, a meeting space and also as a distraction for those who are waiting. For example, interviewee 1 said, *"When a family arrives they have a lot of anxieties to deal with – where they are going to, what clinicians are going to say to them about their child"*.

They also pointed out how successful the pond was being used throughout each day by families. Interviewee 1 exclaimed how it had proven to be *"a big hit"* that was often commented on in Twitter and Facebook. They also pointed out what aspects of the space did not work well. In particular, the reception desk was not used in the way intended, as interviewee 2 noted, *"the boat was intended to enable visitors to go to any person in the boat rather than waiting"*. Many visitors did not notice or understand the boat's open design. Instead, if one visitor was standing at the desk talking to a receptionist, the others stood behind them, rather than walking passed them to another part of the boat. The social norm of 'waiting in line' behind the person already at the desk seemed so ingrained that it was difficult for anyone to breach it. Another interviewee also pointed out that the rail of the ship hindered some groups of people approaching the desk, *"for the people sitting in a wheelchair or small children, this deck is too high"* (Interviewee 5).

All the interviewees mentioned how the information kiosks were rarely used. According to one volunteer interviewee, who spends most of her time near the kiosk, the main reason is that people prefer having face-to-face communication with an actual member of staff than using a kiosk, because of their emotional situation, *"Most of the parents are in a hard situation and feel anxious…After spending lots of time to come here, they don't want to try to find some info from a kiosk, they just talk to people and ask for help. Their situation doesn't allow that"* (Interviewee 5). Sometimes, children went back to a kiosk again, on exiting the hospital, having previously discovered the Peter Pan character on it, *"Parents let their children play with it before they are going back home"* (Interviewee 6).

The outcome from the interviews with the staff and volunteers showed a clear difference between how the various interactive technologies were used and their varying degree of success at distracting visitors. In the next section, we analyse in more detail what behaviours were observed surrounding them.

5.2 Observations

70% visitors coming into the GOSH entrance area either chose one of the seats in section A, B or C (see Fig. 3 left) before moving off somewhere else or being collected by one of the hospital staff. They chose a place to sit down at, after which they usually did not move anywhere else, except if they went to the toilet or the reception desk. The other 30% knew the destination that they wanted to go to, such as outpatients. They were observed to be hesitant on first entering the reception area, looking around for some kind of signage or help. The volunteers on noticing them would introduce themselves. It was noted that hardly any of the visitors used the information kiosks to get help with navigation.

The mornings were found to be the busiest times, with the majority of families starting to arrive from around 8.30 a.m until 11.30 a.m. The average waiting time was 14 minutes. It was also observed that on their way out of the hospital, 60% of people spent considerable time lingering in the waiting area. It seemed that they were either waiting to collect their medicine from the pharmacy or getting ready for going back home. Waiting times in the pharmacy seating area were observed to be the longest. From observations of 41 people (20 groups) waiting there, the average time from their arrival at the pharmacy to their time of leaving was around 2 hours. However, 64% left the area after handing in their prescription and came back later, reducing their average waiting time to around 45 minutes. Most of the adults showed the same pattern of behaviour while waiting during these relatively long periods of time: sitting on a sofa and looking at their phone, but after some time, staring blankly, interspersed with the occasional short conversation with other members of their group. The TV was only watched by the few people sitting directly in front of it. The lack of sound (substituted by subtitles) meant it was difficult to follow, especially by the children. Instead, many of the children who were in this area, on noticing other children at the virtual pond, went over to explore what was happening there.

64% of the 47 groups (families or just parents) chose to sit on a seat surrounding the pond area rather than sit on a more comfortable sofa further back in the reception space. This might have been even higher, since when noticing that the pond seating was full, visitors resorted to sitting further back in section B. Many adults chose to sit where they were able to watch the children in the pond area. Fig. 3 (right) shows the locations of 101 groups that were recorded who sat at the pond seats; 31% chose area ‘b’ which allowed them to watch people passing through the entrance; 20% selected area ‘g’ that faces the middle of the interactive pond; 10% chose to sit inside the pond areas in area ‘f’ (10%) and area ‘h’ (8%); 11% chose to sit in area ‘a’ and 17% in area ‘e’ towards the reception desk. The least popular spaces were areas ‘c’ (1%) and ‘d’ (3%) where it was difficult for people when they sat down to watch others as they were facing outwards towards the wall.

Clearly, the virtual pond provided a popular focal point. When analysing the types of interactions that took place there further we found them to be many and varied: helping others, repeat visits, those with a physical disability, exploratory learning, performative acts, discreet use, and as an ice breaker. We describe each of these below.

Helping others Occasionally, GOSH staff would demonstrate how to use the pond to visitors who were not sure what to do. A few parents and older brothers or sisters also demonstrated to their children or younger siblings how to interact with it. On other occasions, parents were observed trying to direct the attention of their sick children to the pond, especially those who seemed to be rather despondent, as a way of providing a distraction.

Repeat visits Young children, who appeared to be between 2 and 6 years old, used the pond the most. They typically noticed the pond on entering the hospital and made a beline for it. Some were immediately drawn to it by noticing other children using it. On leaving the pond, they then often wandered off the reception area, looking for other things to do, but on not finding anything else, came back to the pond to interact with the fish again. About a third of family groups, who were on their way out of the hospital, stopped momentarily while their children played with it again.

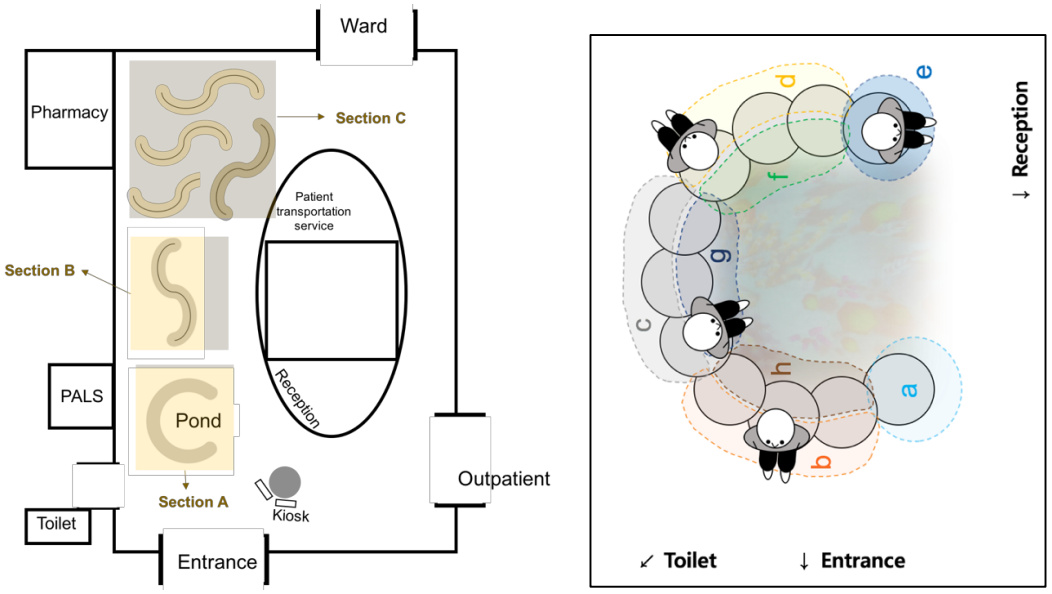

Fig. 3 (left) Schematic map of reception area at GOSH, with sections A, B and C labeled to show different seating areas, and (right) the seating areas at the pond area (a-h) chosen by visitors

Those with a physical disability As GOSH is a specialised children's hospital, there were several young patients observed in the reception area who had restricted mobility and could not use the pond in the way intended. Nevertheless, some still tried to interact with it despite their physical condition. One boy who had his whole body in bandages, and another girl, who had a knee support brace on her knee, both stepped onto the pond very carefully and were able to experience the fish moving. Children in wheelchairs were also observed driving themselves over the pond to see how it reacted. A few tried to interact with it by stretching out their arms and legs while in their wheelchair. While the pond did not react in the same responsive way as with direct interaction, it was possible for wheelchair-bound children to get some reaction from the virtual fish. For children who could not try because of their physical condition, but wanted to have a go, parents often helped out by supporting their body or demonstrating, themselves, to show how it worked.

Exploratory learning – Young children found it easy to work out how to use the floor display, instinctively stepping onto the projected pond with their feet and seeing the fish moving made them move around more. The average time each child spent interacting with the pond was about 2 minutes. Toddlers, aged younger than 2 years, were also observed crawling on it while their parents watched on.

18% of the children observed appeared to have more immersive experiences than others. By this is meant trying out a range of moves, and developing new ways of interacting with the pond by using different parts of their body, including their arms, hands or knees, or by crawling on all four of their limbs on the floor. Two children laid their face flat on the floor and imitated the act of swimming by flapping their arms and legs around. They also laughed a lot when trying out the range of exploratory interactions.

Performative acts About 40% children increased their stepping or jumping actions to see if it would trigger different behaviours after having familiarized themselves with stepping on or jumping around the fish in the pond. It was observed that the more different methods they tried the longer time they sustained interest in the pond. 20% of the children aged over six years, actively developed new ways of jumping, that they discovered had the effect of causing a dramatic change in the fishes behaviour in the pond. The most popular method was a

long jump, where children discovered that a larger change happened in the pond when they made a big jump from outside it into the middle. For example, after trying several big jumps, one girl ran from further afield to make a bigger jump, imitating the steps of a long jumper. Children also took turns when jumping onto the pond; after one child had completed a jump they stood back to let other children, who were watching on from the sidelines, have their turn to jump in a similar performative manner.

The parents also took part in the performative acts by encouraging their children to try out different jumps, which had a 'showing off effect' [21]. Onlookers sitting nearby became the audience. A 'honey pot' effect [7] was also observed to occur, where more visitors from further afar were drawn in.

Discreet use Older children, aged over 10 years, did not interact with the pond but typically watched on when sitting nearby. They appeared self-conscious, considering themselves too old to be seen using a pond display that was designed for younger children. However sometimes it was observed that a few of the older children had a sneaky try when they thought no-one was looking at them. They did this by momentarily stopping by the pond, then lightly stepping on to the pond surface, appearing to walk passed, and then moving away from the pond as if they were still walking. Three adults were also observed acting out similar discreet moves, when it appeared that no-one else was looking. But they did this when sitting on a stool next to the pond, moving their foot slightly on the pond surface and at the same time avoiding eye contact with others sat at the pond. Some of the volunteers and GOSH staff were also observed using it. For example, while two staff were standing in front of the pond talking to each other, one tried to step onto the fish ever so subtlety, while the other watched on without commenting. Then, when the first staff member turned around to leave, the second one discreetly stepped onto the pond, behind the first man's back, to try it himself. When the first man looked back and noticed what he was doing, he seemed a little bit embarrassed at first, but then smiled bashfully at him.

Ice-breaker Interactions between parents and children, while sitting on the seats or having fun at the pond, were often facilitated by being in close proximity and facing one another. As the set of stools were in a formation of the character 'C', people naturally faced each other when they sat towards the inside of the pond. This informal face-to-face set-up readily encouraged strangers who sat there to talk with each other. Mostly, a conversation started with them talking about their children, or asking for information about the hospital, such as the WiFi password. Adults who had selected a seat facing the pond often watched other people's children having fun. Sometimes the children looked up at them, and exchanged a smile and a few words. Usually, the adults reciprocated a response, resulting in a mutual positive effect.

Children from different groups, however, tended only to interact with each other when in close proximity at the pond. Unlike their parents, however, they did not engage in small talk but showed more interest in each other by following or copying what the other did at the pond. Moreover, they seemed intrigued by the other children. They also stayed for longer at the pond when there were other children there. Even if they had left the pond and moved to another area, they came back to see what others were doing who were playing there. This occurred most when there was only one child in a group.

In sum, our analysis of the different kinds of interactions that took place at the pond display has been able to demonstrate how effective it was at providing a form of positive distraction for visitors when arriving, waiting and leaving the hospital.

6 DISCUSSION

One of the main findings arising from our study was the high level of engagement witnessed at the floor display. The virtual fish pond was frequently used every day by families visiting and proved to be highly accessible, drawing children of all ages and physical (dis)abilities and, occasionally, some adults to use it. It was also able to serve multiple functions while facilitating creative use. For example, children experimented with different parts of their bodies to make the fish react. Parents were also seen helping their physically disabled or wheelbound children try interacting in the space through improvising with their restricted movement. Moreover, young children appeared uninhibited and positively distracted when using it while adults were able to watch

along and become distracted themselves. Our observations also revealed a range of *unexpected* behaviours; parents let there toddlers crawl over the pond floor as they might at home and not appear to worry about how clean the floor was; grown-up adults were tempted to try out interacting with the pond when no-one was looking, while strangers smiled and talked to each other across the pond when watching their or other's children peforming at it.

In contrast, limited group behaviours were observed outside the pharmacy area where the TV was positioned. In this space, families often just sat waiting, appearing bored, restless and not engaging with each other or people from other groups. Such a marked difference between the impact of the two technologies on visitor behaviour suggests that there are clear benefits of designing and situating a user-centred, interactive technology in a shared space versus simply placing an off-the-shelf, TV monitor on a convenient wall. Whereas the virtual pond engaged many visitors in a variety of ways, the TV was only watched by a few in a passive way. It could be argued that TVs are more cost effective, as they are relatively cheap and easy to set up and maintain compared with a more expensive customized technology, that also requires software maintenance (e.g. rebooting, upgrading, changing sensors). However, this is short-sighted since it overlooks the many benefits of having a focal point that can positively distract visitors in a variety of ways.

We also discovered that the information kiosks for helping visitors plan their route were not used in the way envisioned. This kind of technology can be quite costly especially if the software needs to be customized for the hospital. As we found, most visitors when first entering the reception area, preferred to ask someone at the reception desk or a volunteer standing nearby, or look for physical signage. Talking to a human being can be much more reassuring when in a stressful situation rather than searching for directions using an unfamiliar interface. Given this need for human contact on arrival at the hospital, it is likely that had the more sophisticated distributed navigation system been implemented, visitors would still have deferred to asking a human being for directions.

6.1 Distraction as a human-building interaction (HBI) design principle

One way in which the virtual pond appeared to work as a distraction was by acting as a temporary playground for children (and sometimes adults) to explore and try out activities. It also acted as an icebreaker, enabling strangers to watch on, and at certain points, participate in small talk, while watching theirs or other's children playing in the pond. The opportunity to 'people watch' without feeling uncomfortable also served as another form of positive distraction.

More generally, the study has shown how a diversity of visitors can be drawn into a shared physical space – in this case a digital pond surrounded by seats – that at certain times becomes an ad hoc stage, where families watch their children perform, taking turns to join in, while legitimizing others nearby to watch on. As such, public interactive floor spaces offer much potential for being designed to be universally accessible and which can be made to be understandable at a glance. For childrens' hospitals, it is relatively easy to come up with familiar content that children know what is the underlying activitity/story/game, e.g., fish that move, plants that grow and animals that play hide and seek.

Our study has also shown how this kind of technology can alleviate the stress of waiting for a range of people [6]. People in the periphery can be drawn to watch what is happening in the space without feeling compelled to take part. The notion of 'licence to play', which Akpan et al. [2] discuss, is relevant, where the pond space is perceived as a play area and, in doing so, changes how it is viewed by children and parents. The ad hoc coming together of family groups in the GOSH reception area creates a shared awareness, enabling visitors to either observe from the periphery of the space or be at the forefront of the action. Similar findings have been demonstrated when evaluating temporary interactive digital facades at festivals, on historic buildings, facades or in civic centres [22]. However, the type of installations and the spaces they were situated in were often much larger and where more people were gathered, setting up different affordances and conditions of whether to take part or watch. The presence of children may also be central; unlike adults, they don't feel awkward or inhibited in a strange public place, and it maybe this that helps initiate conversations among

strangers. This raises the question of whether the same positive effect that was observed at GOSH would also occur in adult hospitals, where children are not the centre of attention.

6.2 An adapted conceptual framework for visitor engagement with interactive floor displays

Our analysis of the way the GOSH virtual pond display was used showed how visitors move through thresholds and peripheral/focal spaces and, in doing so, transition through different levels of commitment and engagement, from passers-by to participant [e.g., 9, 34]. However, compared with other HCI research on public displays, we also looked at how families arrive together, and the role children play in initiating interactions around the pond. As such the context and conditions for interaction differ to some extent from the 'trajectory' type frameworks.

We observed how young children are directly drawn to the space as soon as they enter the hospital and also linger at it when leaving. They will also readily join in the activities of those who are performing jumping acts through adopting a turn-taking strategy. In doing so, they legitimize adult social interactions and behaviours that would be awkward or strange to engage in. For these to occur, however, requires that seating be configured around the display space for families to sit on while waiting. This condition is not the same as when designing display/media facade installations in other indoor/outdoor public places. With this in mind, we propose an adapted conceptual framework, that shows how to engage a diversity of visitors around a floor display, from first noticing it on entering a building to immersive engagement:

(a) Initial entrance: This is the first place where people are likely to come across an interactive floor display, such as an interactive pond. It needs to be highly visible and approachable as time spent here is likely to be relatively short as they move onto another destination.
(b) At the display: Providing seating around the floor display can lure people to sit there and stay put; they will often select a seat that enables them to have a good viewing spot so as to be able to people watch.
(c) Engaging awareness: This is where visitors in the area become interested in what is happening at the floor installation and switch to watching who is currently engaged with using the display
(d) Subtle interaction: This is where visitors can 'dip their toe' by having an initial try using the display. Having seating around the display enables this kind of subtle interaction without having to commit or feel socially embarrassed.
(e) Immersive interaction: This is where visitors fully commit to interacting with the interactive display, including playing, experimenting and performing.

The framework is intended to highlight the importance of designing the surrounding space and especially the seating for where visitors can situate themselves as well as taking into account the process of how an individual moves from one role and space to another.

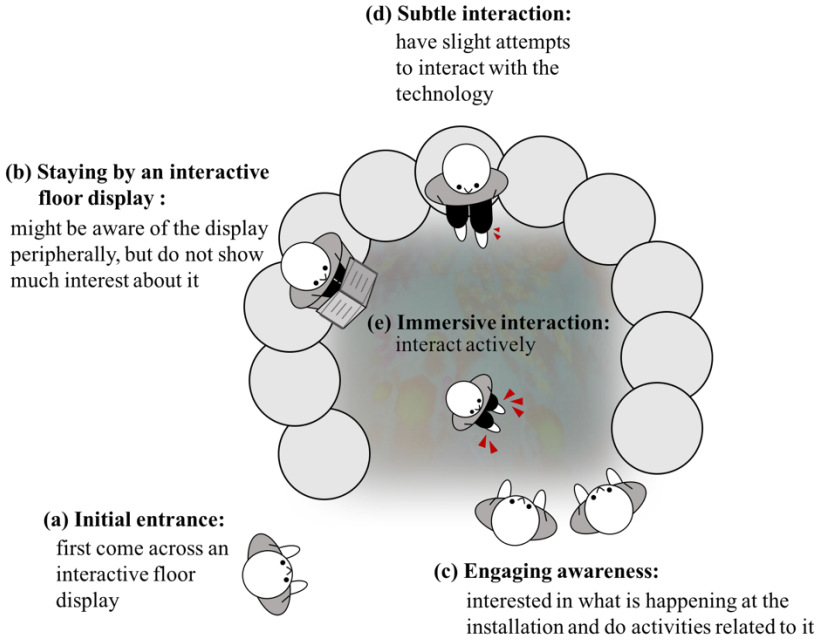

Fig. 4. A conceptual framework that shows how visitors approach, observe and engage with an interactive floor display surrounded by seating

6.2 Specific human-building interaction design recommendations

6.2.1 Which display type: TV, interactive wall or floor display?

Many interactive technologies that have to-date been placed in reception areas are wall-based. These include the ubiquitous TV monitor and larger public digital screens. However, while these types of monitors are easy to set up and can be situated out of the way of people moving through the area, they tend to run in the background. They also usually draw the attention of only those in close proximity to them. The experience is largely passive. Moreover, the necessity of having silent TV screens in a public space showing content with subtitles makes them less attention-grabbing. Children, in particular, were observed in our study to rarely watch the TV monitor for more than a few seconds. It is also quite demanding to follow subtitles, which can make it more challenging to follow, especially for visitors who are in a state of anxiety. This suggests that they have limited ability to positively distract visitors.

Interactive customized walls, such as those previously mentioned should fare better in drawing children towards them. When standing in front of one, children can wave their arms and move their bodies to elicit responses from the interactive software characters/objects. However, the act of standing in front of a wall display means facing away from other group members who might be watching. This makes it more difficult for a child to engage at the same time with other members of their group than when they are sitting on stools around a floor display, facing each other. Interactive floor displays, on the otherhand, have quite different affordances, opening up the space to be more social. As seen from our study they can encourage a diversity of subtle or more explicit interactions where others can join in readily by watching, commenting or talking with the acting child, while sitting in the same area.

Another reason why floor displays may be preferable to wall displays in hospital waiting areas, is that they may be less prone to display blindness [25, 35]. By this we mean the tendency of people to ignore what is being shown on a public display as they assume they will contain irrelevant content, such as advertisements. Floor displays are less likely to be overlooked in the same way because people do not have the same expectations as to what they will show [7]. Also, people are naturally drawn to looking down at what is projected onto the floor as they survey the ground before them when moving through a space [8]. However, the downside is that users are always in direct physical contact with the floor, limiting what they can interact with. This constrains the kinds of interactions that can take place; people can either use their feet or other parts of their body to tap or push items; they can run through a virtual space and make objects move away or towards them. As such, designers are limited as to what they can represent on a floor display that users can interact with. However, having such physical constraints may in fact be what makes this type of display effective as it is obvious what to do – at least getting started. The coupling between body movement and effect is also more direct than say waving one's arms in front of a wall display and trying to connect this with what appears on the screen.

It is possible, of course, to add other input mechanisms to a floor display to extend what people can do. Schmidt et al. [41], for example, developed a novel technique called kickables which are tangible objects that users operate with their feet. Physical balls can be kicked over digital representations that provide feedback, depending on how they are kicked and the forces used. While this type of input device offers more scope for interactivity in museum and gallery spaces, however, they could be seen as a potential hygiene and safety hazard for hospital settings, because of the risk of tripping over them or cross-contamination through children touching and picking them up.

6.2.2 Where to place interactive technology in a public space?

The spatial location of a floor display plays an important role in how it was used. There are clear benefits of placing an interactive floor display in a central location, where it can be readily seen, easily approached and interacted with. For GOSH, the spot chosen was at the front of the reception area, that was close to the main entrance, the reception desk, the toilets and the outpatient area. This enabled the digital pond to be seen on first entering and being noticed again on exiting. Surrounding it with seats enables family members to sit down and watch on. However, a trade-off of having adjoining seating is that they can hide the display from people when initially glancing at it as they walk into to the reception area. However, the 'honey pot effect' [9] can counteract this, where on seeing one person using it, others are drawn to what they are looking at.

6.3 Limitations of our approach: measuring distraction in relation to comfort and anxiety

A limitation of our research was not having a way of directly measuring changes in patient and family anxiety levels. Compared to other interaction design principles, such as ease of use, efficiency, and comfort, that can be operationalized and measured through surveys, performance tasks and new sensing technologies, it is much more difficult to measure and analyse distraction in the context of how it could affect human anxiety. As it was not possible to monitor or ask patients how they felt on first entering the reception area when waiting there or after their visit - given how potentially ill and/or anxious they are - we had to rely on indirect methods of interviewing staff and observing body posture, level of engagement/boredom and the different kinds of interactions that took place that could be observed. Hence, we infered the extent of positive distraction in terms of how people appeared in this vicinity: through looking excited, agitated, bored, interested, playing, relaxed or talking with their children or other adults. Our judgements could have been inaccurate, for example, estimating the age of a child from their appearance can sometimes be difficult. We argue, however, that such indices can still provide a comprehensive, albeit, indirect account of distraction. While in the future, as body sensing technology becomes more mainstream, affordable and feasible, it may be possible to ask some visitors, e.g. outpatients and their families who are not sick, a priori, to wear familiar wearable devices that can 'measure' their anxiety levels through body functions (e.g. galvanic skin response, heart rate), it is questionable as to what else could be inferred from doing so. Moreover, this kind of automated sensing is equally likely to produce

'noisy' data; compounded by the participants knowing they are being measured, that might increase their anxiety levels further. Hence, sensing bodily functions to measure anxiety in real world settings may not reflect the actual ways of experiencing it, for example, what it is like waiting nervously for results, and going to a hospital with strongly associated negative emotions. It would also be difficult to tease out how an interactive installation impacts upon these measures because of all the other contextual factors at play.

7 CONCLUSION

A basic requirement for the design of future human-building interactions is to configure physical spaces so that they enable people to feel comfortable when working/living/socialising, etc., in them. With the advent of smart building technology, it is increasingly possible to sense, detect, infer and change various environmental conditions to achieve this – with the goal of optimising different aspects of comfort more efficiently. However, people entering hospitals, medical centres or other healthcare settings, have an additional burden that needs to be taken into account; that is to discover more about their - or someone else they are visiting - symptoms, illness, or ongoing treatment. This state of unknowing typically incurs being in a heightened state of anxiety – waiting for good or bad news. Such a state can be exacerbated by entering an unfamiliar building that often has strong negative associations. Hence, even more care needs to be taken in how to design physical spaces so as not to increase anxiety while also trying to help people entering them feel comfortable. This is especially challenging for specialised hospitals, such as those for children, that have their own vulnerabilities.

Designing for hospital reception areas, therefore, is not simply a matter of providing for more 'comfort' through providing pleasant surroundings. Our research has shown that a more effective strategy is to address anxiety by designing for positive distraction. As a heuristic, it can sit alongside other public hospital space requirements – concerned with functional, feasible, aesthetic and hygiene aspects. However, as we found the degree to which a technology can distract, varies and so when deciding on what technology to implement in a waiting space, opting for a cheap and easy to set up option, such as placing a TV monitor on the wall, may not prove be the most effective.

Finally, our study has shown how distraction can be operationalised and analysed as a central design principle by which to help alleviate the negative emotional state that is associated with illness and clinical environments, through considering how to design and place interactive installations for a range of people. Our observations of GOSH's reception area, indicated the benefits of having an interactive floor display situated in the waiting area of a hospital. Rather than promoting the use of smart sensing technologies as a way of measuring distraction and its impact on anxiety, we have demonstrated the value of using qualitative methods to reveal and understand in detail how an interactive experience affects distraction, emotionally, psychologically and socially. The design of future hospitals need to consider not only the functional, aesthetic, comfort, health and safety requirements of its patients but also how to address and reduce heightened anxiety when first entering and waiting in the reception area.

8 ACKNOWLEDGEMENTS

Thanks to all the staff at GOSH who helped with the study, especially Stephanie Willamson in redevelopment.

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