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Abstract
Waiting in healthcare settings can be an anxious and fearful experience for children and their families. Opportunities for play are an important part of child-friendly healthcare and have been shown to reduce waiting anxiety. Conventional toys and games, however, usually have contact surfaces through which infections may be passed. Additionally, they often require fine motor movements which may not be available to children with disabilities. In this paper, we describe the design of an accessible and interactive large display to meet the needs of a hospital waiting room. We discuss the detailed design requirements, the participatory process by which the design was developed, and our plans to evaluate the efficacy of the interactive display for reducing waiting anxiety in healthcare settings.

Keywords
Interactive display, new media, healthcare, children, rehabilitation, disability, universal accessibility

ACM Classification Keywords
K4.2 Social Issues: Assistive technologies for persons with disabilities, H5.2. User Interfaces

Introduction – Not just child's play

Play is the primary occupation of children through which they explore, discover, and learn about the world. In healthcare settings, play has a number of additional and well-defined objectives [1]. Specifically, playful interactions are used to inform and reassure children (and parents) who have complex medical conditions or require surgery; children engage in play to self-soothe, alleviate anxiety, and cope with difficult medical experiences; play is also used to motivate and encourage children through cognitive, social, and physical rehabilitation therapies. As such, there are innumerable applications for interactive displays in healthcare settings to convey important information and/or to provide opportunities for playful and meaningful interactions, as is the focus of this paper. Successful use of interactive displays in healthcare hinges on a participatory design process. The following presents our experiences and some of the unique challenges of designing for healthcare spaces.

Addressing a well-defined clinical need

Holland Bloorview Kids Rehabilitation Hospital is Canada's largest children's rehabilitation centre. Holland Bloorview hosts over 52,000 out-patient visits per year for children/youth with a wide range of disabilities including cerebral palsy, autism, and acquired brain injuries. The entry point to the clinic is a well-designed waiting space with comfortable seating, natural light, and aesthetically pleasing interior design as depicted in Figure 1. Despite these design features, the need for entertainment options to alleviate both boredom and waiting anxiety has been voiced by staff, clients, and families. To address this clinical need, a steering committee was formed consisting of engineers, designers, social scientists, physicians, therapists, artists, parents, clients, senior staff and building management. Design requirements for the space were delineated and the types of experiences that would make for a positive waiting time, were reflected upon. The following summarizes the primary design requirements: (1) Protects safety (avoids spread of infections, sensory overstimulation, physical injury); (2) Promotes positive waiting experiences (i.e. non-addictive but engaging, opportunities for social interactions, encourages calm and relaxing activity); (3) Affords universal accessibility to children regardless of abilities or disabilities, age, gender, culture; (4) Ensures comfort of clients, parents & staff (i.e. does not reduce waiting space capacity, not disruptive or noisy); (5) Blends aesthetically with existing architecture; (6) Maintains durability (i.e. long lasting in structure and content, easy to clean); (7) Affordable to implement and maintain.

Figure 1. Waiting space for an outpatient clinic at Holland Bloorview Kids Rehabilitation

Design Conceptualization and Development

Brainstorming design solutions
In past years, a number of entertainment options have been presented in this waiting space. A large aquarium offers short-term amusement to families. Conventional toys and books, while enjoyable, have contact surfaces with risks for cross-contamination. Video games were not accessible to clients with fine motor limitations. After extended deliberation, it was concluded that the majority of design requirements could be met by a wall sized video projection with imagery that could be controlled by users of the space.

Modes of interaction – designing for accessibility
A number of different ways of interacting with the display were considered. Touch surfaces introduce risks for infection spread and usually require fine motor skills that may be difficult for some children. Conversely, camera-detected large body movements require gross motor skills which may not be available to others and cameras raise perceived privacy issues. Likewise with vocalizations, which have the added risk of becoming disruptive and noisy. Physiological signals (e.g heart rate) are universally available, but usually require contact sensors to access and may be difficult to distinguish when multiple users are engaged with a large display. Instead, we decided to detect presence via 100 contact floor sensors (Tapeswitch Canada, LondonMat Industries, Ontario). Additionally, floor sensors, unlike touch surfaces, do not typically lend to spread of infections. Use of a sensor floor also ensured that every individual whether walking, wheeling, standing, or sitting could interact with the display in some way. To ensure that children with motor disabilities were not disadvantaged, we inverted typical "rules of engagement" in that stationary or slower movements caused more to happen on the screen while, fast movements (e.g. walking, running) have minimal effect. In this way, hyperactivity is minimized and the waiting space maintains an atmosphere of calm.

The interactive experience
Partners at the Ontario College of Art & Design University were engaged to create the interactive experiences which would be presented on the large display and controlled by the floor sensors. The designers were presented with the established design requirements, conducted site visits and reviewed studies on perceptual challenges within the target user groups. They were given the opportunity to interact with the custom hardware and software that connected the floor sensors to the display controls and the structure of the data exchanges. Extensive ideation sessions followed which explored possible interaction structures (game, narrative, ambience, user-generated content), levels of social engagement (onsite, online, multi-user) and visual themes (texture, environmental, organic, colours). The relationship to the space was considered, including the user's line-of-sight and proximity to the screen as well as the experience on approach. Scenarios were developed for different numbers of participants (i.e. no users, single or multiple users). Twelve possible implementations were mocked-up for consideration within the design group. These were modified, merged and winnowed down to four appropriate proposals for consideration by Holland Bloorview. Animations and interaction at this stage were simulated using the prototyping capabilities of Flash and Processing. Two scenarios were selected for further development and eventual implementation.

(1) Enchanted Forest combines hand drawn and software generated imagery to create a grid of 100 plants on the screen which corresponds to the 100 in-floor sensors. Flowers, shrubs or trees begin to grow when a user triggers a sensor and continue as long as they remain stationary. Once full-grown, the user can move to another sensor and grow another plant, eventually creating a whole forest.

(2) MicroScope consists of software-generated abstract shapes suggestive of cells under a microscope. A shape is created for each user that enters the space and moves across the screen as the user moves across the floor sensors. The shapes of users in close proximity respond and interact with each other.

Both interactions were intended to stimulate exploration and discovery while rewarding calm movements and social behaviour.

Measuring Impact

While it is sometimes difficult to operationalize the goals of an interactive display, it is nevertheless extremely important to measure their impact. This is particularly true for healthcare applications where limited resources must be optimally allocated. In this case, we will compare state anxiety [2] of children and parents waiting with and without the interactive display. Behaviour mapping [3], an observational technique used to systematically record behaviours in specified settings, will be used to describe activities, social interactions, engagement, and emotions within the waiting space. This technique is particularly useful for providing consumer perspectives and a systematic record of 'actual' use of play environments [3]. 'Actual' use will also be quantified via floor sensor activation patterns. Lastly, family/staff feedback questionnaires will be collected to evaluate if the interactive display improves the overall clinic experience and satisfaction with Holland Bloorview's services & care environment.

Conclusions

A number of recommendations for the design of interactive displays in healthcare settings emerged from our team's experiences: (1) To be of value, the interactive display must address a well-defined clinical need; (2) The decision to use an interactive display should emerge from the organizational and user design requirements and *not* simply from the desire to create an interactive display; (3) A participatory user-centred design process is vital to the success of the project; (4) As in all public and urban spaces, universal accessibility should be considered with the utmost care. Creativity not only in the selection of interaction modes, but also in the rules of engagement, can maximize participation and inclusion in the interactive experience for all.

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