Mazi: a Tangible Toy for Collaborative Play between Children with Autism

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Abstract
Playtime is an important activity for child development as it stimulates as well as predicts cognitive, motor, emotional and social skills. Children with autism may find it difficult to socialize, particularly initiating and maintaining human interactions. Consecutively, it is thought that playing with peers is often a challenge that many children avoid by simply playing in solitary mode. We present the design of Mazi, an e-textile sonic tangible user interface (TUI) designed with the aim of promoting basic social skills; stimulating spontaneous, independent and collaborative play; and providing sensory regulation opportunities. Mazi was tested in a Special Education Needs (SEN) School based in North-East London, with a group of five minimally verbal children with autism aged between 6 to 9. The results show great potentials for TUI implementation in educational settings as a way of promoting social skills through carefully designed playful and recreational activities.

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Introduction
Playful activities provide the building blocks for stimulating various aspects of functional brain development like social and communication skills, emotional regulation, and cognitive and physical abilities [8]. However, social interaction might be challenging for children with autism are there seems to be an impairment in early social skills development

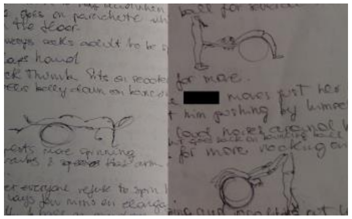

Figure 1 Hand sketches and notes taken during the observations in P.E

Figure 2 Mazi in the making

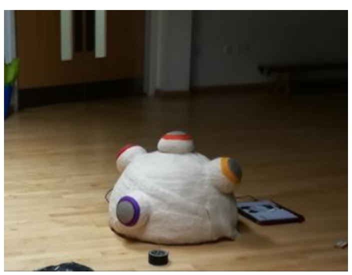

Figure 3 Mazi in the Dance studio

which activates specialized brain mechanisms biased towards people e.g. preferences for human faces vs objects and human voices vs digital ones. These specialized mechanisms usually strengthen over time through exposure to new information due to brain plasticity during development [6].

Precursors of social development are basic skills like: eye-gaze, attentional engagement, joint attention, sharing experiences (i.e. protodeclarative pointing) and objects, turn-taking and imitation [8, 12]. There are many approaches used in educational environments aimed at developing children's full potentials. Our study adopts some of those [2, 10, 11] used by the school we collaborated with, to set-up the environment, promote and mediate social activities and as an inspiration for our evaluation framework [9]. Studies on children with autism recently focus on implementing technologies such as tabletops, robotics, computer vision and VR as a way to promote social interaction [1, 4]. Most target children with low support needs or verbal and few target children with moderate to severe challenges. From our experience working with children with autism we believe that TUIs are a valuable technologies to stimulate and mediate social activities and should be given high importance when researching HCI for moderate to high support needs autism. Many researches have demonstrated the benefits of TUIs for children's engagement in areas related to motor skills development, music therapy and well-being [7, 13]. To our knowledge there is no research that targets social skills development and support self-regulation in children with autism by using e-textile combined with music. We'll introduce the design of Mazi [9], a textile musical TUI developed around 5 children's profiles, and we'll briefly present the results of our 5 weeks study.

Design Principles and decisions

The design principles that we addressed were threefold: a) build on children past experiences and preferences; b) support self-regulation; c) encourage social activities. The shape of Mazi was inspired by the preferences of the children - during the formative phase of our study we noticed that most children used the therapy ball and some liked textile materials and tactile activities (Figure 1). We were also inspired by theories within the workplace on circular configurations to offer more collaborative and social opportunities. To facilitate intuitive use and togetherness we adopted a principle of shareability [5]. We did so by having well-spaced and identifiable active areas within the technology that gave each child opportunity to gather around the artifact to play together and practice skills like proximity, sharing eye-contacts, smiles and touch. The materials had to be resilient and the structure sturdy enough to sustain use and possibly abuse over a prolonged period of time. Important to us was that the technology had to be running in stand-alone mode to avoid having cables interfering with the interaction flows. As reported in [9] Mazi (Figure 3) was tested in the Dance Studio of a School specialized in autism based in North-East London, UK, every Thursday afternoon, and was fitted within the scholastic routine of the children. The sessions were semi-structured and open-ended, and each was 30 minutes long. The Teaching Assistants working with the children that day accompanied each of them. Mazi worked in stand-alone mode for the duration of the entire study. The children (Figure 4 Children showing a creative use of Mazi and self-regulation strategies.) could press, squeeze, lie on, climb on and move the installation around the space. Basic social skills like turn taking, eye contact, smiles, initiations of interaction, sharing experiences, attention

Figure 7 Children showing a creative use of Mazi and self-regulation strategies.

Figure 8 Children gathered around Mazi

Figure 9 Children social skills i.e. smiles, sharing, eye-contact, proximity, turn-taking and also competitive play

and places were observed throughout the sessions (Figure 5, Figure 6). The children also showed creative use of the technology and there were signs of attention towards it and peers interacting with it, even when not in proximity of the TUI. The cause-effect interaction allowed the children to act at the same time and we noticed instances of playing together. Children exhibited signs of engagement with the TUI beyond the adult's facilitation through smiles and all of them showed spontaneous play. The mobility aspect of the tangible offered a weight bearing activity and opportunities for self-applied deep pressure. The design provided clear entry and access points. We adopted a user-centered design approach and closely collaborated with staff members and therapists of the school to gather as much information as possible about the children in order to develop a compelling design. The data-gathering period lasted around two months and included interviews with Teachers and teaching Assistants, Occupational Therapists and parents of the children. We collected various materials i.e. Individual Education Plan, Performance Scale, Social Communication, Emotional Regulation Transactional Support Stages, Positive Behavior Support Plan, triggers, likes, dislikes and personal notes taken during the observations. This process allowed us to have a rich profile of each child, which facilitated our understanding of the children's sensory profiles, likes and dislikes and helped shape the research around them.

Technology and materials

Mazi is made of layers of polyester padding and merino wool that's been felted to cover a soft-play dome bought on Internet. Added on top of the main body there are five hemispheres made by covering inflatable balancing hedgehogs, sold on the market for physical exercise, with more wool fiber (Figure 2). We then felted their bottoms onto the body and on top we sewn round patches of Silver Jersey Fabric. We connected the hemispheres to the circuit board [3] placed on a side of the body under a layer of felt sheet. Mazi was powered by 3.7V Lipo battery. [3] turned our conductive material into a digital interface that enables polyphonic playback. Each of the "bubbles" triggers different notes specifically chosen for our study to minimize the chance of error when playing the sounds together. The size of Mazi is around 600mm in height x 900mm in diameter and it weights roughly 11 kilograms.

Demo set-up

When demoed Mazi will be powered via USB which will unfortunately affect the mobility aspect of the installation but the piece will provide the same opportunities for collaborative play and sensory regulation. If the active areas are touched notes from a pentatonic scale based on C major are triggered. The notes can be played simultaneously to stimulate collaborative and social play opportunities around the artifact. It would be best to place Mazi in a space close to a power socket and yet with enough space around it to allow people to, for example, lay on it, or sit next to it on the floor if they wish. It should be noted that Mazi creates loud sounds and people might be noisy when playing with it. A video of Mazi can be seen at here.

Conclusions

Through carefully designing playful open-ended TUIs and semi-structured recreational activities tailored to the children and their sensory profiles, researchers could improve children's lives. Instead of focusing on age appropriate behavior, we found that by working on mastering basic social skills; supporting sensory regulation; and nurturing children's potentials through carefully designed environments, child's lead play and spontaneous interactions emerged which were not observed during the data gathering period.

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