Encouraging Speech and Vocalization in Children with Autistic Spectrum Disorder

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Abstract

Technology can improve the life of those with Autistic Spectrum Disorder (ASD). Specifically, some children with ASD are not fortunate enough to acquire the ability to communicate with language on their own. With language being an important method of communication, socialization, and interacting with the world, these children need researchers to develop new solutions to help teach vocalization and speech. Without speech, these children will have difficulty communicating their needs, wants, and emotions, as well as being able to function within society at large. This paper examines the existing HCI research on ASD, as well as proposes a new direction for investigation.

Introduction

During the normal development of a child, language is acquired without much explicit effort by parents, practitioners, or the community. However, some children, such as those with Autistic Spectrum Disorder (ASD), are not fortunate enough to acquire this skill on their own. That language is considered "a unique characteristic of human behavior… [that] contributes in a major way to human thought and reasoning"[11], these children need our help to learn to communicate and function in the "real world". Without speech, these children have difficulty expressing their desires, emotions, and communicating on a day-to-day basis. HCI is poised to develop new techniques that use technology to assist practitioners and parents to teach their children with ASD to talk and develop normally. With 1 in 150 children being diagnosed with ASD [4], the need for new solutions is growing.

A Brief Description of Autistic Spectrum Disorder

ASD is a developmental disability impacting social functioning, such as empathy, basic interaction and communication. It is important to note that autism affects each individual differently. These differences cause a wide range, or spectrum, or conditions ranging from individuals who are "high-functioning" or having only slight delays in communication and social functioning, to those who are "low-functioning" having a greater challenge of interacting. Other notable characteristics of many individuals with autism include "insistence on sameness… Preference to being alone… spinning objects [and] obsessive attachments to objects " [1].

Communication Treatments

In the 1960s, Ivar Lovaas began teaching children with autism new behaviors through a technique called "applied behavior analysis", in which a behavior is encouraged or discouraged as it encounters environmental consequences. In short, his technique relies upon using objects, food, and actions as rewards for desired behavior (prompted by a researcher) [11]. Over many trials and sessions, children with autism eventually learn to respond in a predictable fashion by interacting with people in their environment. There are three main drawbacks to this form of treatment:

- It requires many sessions with trained professionals who are in short supply. This can place a financial burden on the family.
- Teaching sessions require intense attention and prolonged contact from a practitioner or parent.
- The child must interact with a human being. One characteristic of ASD is anxious, detached, and "alone" interaction with other individuals [2, 6]. Thus the interaction with a human being, as the primary mode of teaching, might pose some degree of built-in difficulty for the ASD child.

HCI Research on ASD Treatments

Existing work by HCI researchers has approached ASD from three primary directions. Work by Abowd and others have explored the benefits of technology to aid the diagnosis process [5, 8, 9]. This research is crucial, because early detection allows children to begin treatment earlier, allowing them to catch up faster to their non-autistic peers. Further, this work allows us to better understand how to identify autistic characteristics. Although greatly beneficial, this research does not provide a direct method to enhance the education of children with ASD.

Researchers have also explored the effect that technological environments have had on the process of assisting children with autism to learn how to interact with other human beings [7, 14]. This work uses virtual environments, as well as virtual peers, to create situations in which the children with ASD are comfortable. They are then able to learn person-to-person interactions, without the apprehension of having another person in the room. This work, however, primarily has dealt with "high functioning" children, or those who already know how to speak and have a deficit in social interaction. Therefore, it is hoped that principles learned from this body of literature will have the potential to be applied to research targeting children with ASD who have not yet acquired speech.

The third approach seeks to encourage children with ASD to "play," where playing is mediated through technology [10, 12, 13]. By creating technological methods of interaction (visual displays and physical robots), play and comfortable interactions can be garnered from children with autism. There is a feeling of "safety" by having the main form of interaction occur with non-humans. Further, these devices allow the child, rather than a third party, to be in control of the interactions. This research has much potential. To date, however, it has not focused on encouraging more communication-based activities, such as speech and human-to-human interaction.

A Proposal for a New Direction in Research

Through this analysis of existing approaches, we believe there is potential to create a new direction of research, focusing on using technology to encourage meaningful speech in low-functioning children with ASD. Speech would allow these children to express needs, desires and live more normal lives in society. The literature provides strong evidence that interacting with technology often can motivate children with ASD. Further, existing literature shows that real-time visualizations, which act as social mirrors, can influence communication interaction [3]. Therefore, we see the potential of technology to aid teachers in the development of sounds, words, and speech; thereby contributing to what is an exclusively human-to-human interaction. By introducing technology into this form of treatment, we believe we can alleviate a degree of apprehension experienced by the children when interacting with humans, and provide teachers with a new technique to complement and supplement their existing approaches.

Some of the literature has successfully encouraged play by leveraging visualizations that use abstract imagery (shapes that do not directly map to real world objects). Further, research targeting human-human interaction through training on virtual environments shows the potential benefits of training with this technology. We believe that combining aspects of these two approaches could facilitate a new understanding of sound and speech. These results lead us to believe that a similar approach could be used to help children with ASD understand and control their sounds by visualizing their voice. These visualizations could be used as form of reward for making correct sounds, or as a form of feedback to allow them to visually comprehend the sounds they are making. By constructing these visualizations using hand held devices, the learning experience could also be easily extended to day-to-day life, rather than being limited to an office or a school.

Current Research

In order to test whether computer generated stimuli (auditory and/or visual) can be constructed to encourage/reinforce sound production in children with ASD, we have begun the first phase of this research project. Our study attempts to uncover the effect of different permutations of auditory and visual feedback on the vocal production of children in our target population. We have constructed approximately a dozen varying types of visualizations, as well as 4 different metaphors for sound feedback.

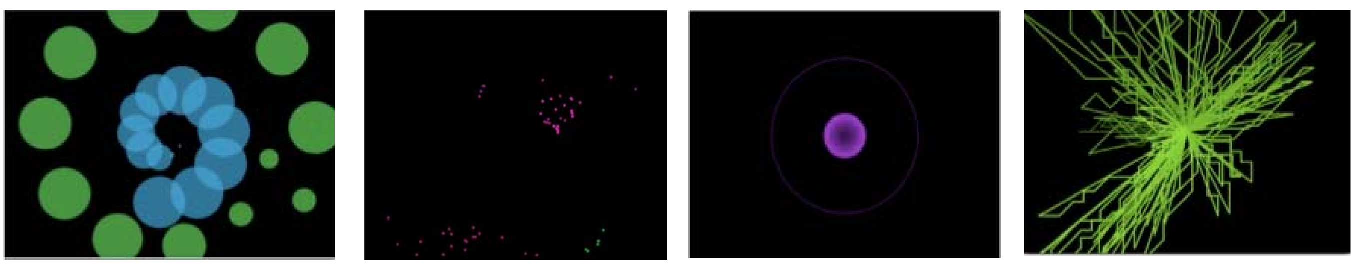

Figure 1. Examples of Visualizations used in Phase 1

Visualizations fall into 4 categories; Falling, Spinning, Found Imagery, Flashy (See Figure 1). We chose to model falling objects and spinning objects in an attempt to replicate stimuli that seems to impact children on the spectrum in the real world. We theorized that because some children enjoy watching objects falling, and spinning objects (as well as themselves) we could leverage that interest by bringing these types of motion into the digital domain.

Children enrolled in this first phase of research attend 6 sessions in which a researcher presents them with approximately 8 different forms of feedback to sound production over about a 40-minute period (Figure 2). Each combination of visual and auditory feedback (trial) is separated by a period of play and relaxation for the child, in order to maintain a positive and stress-free environment. Software, on the systems presenting the feedback, logs critical data points about the child's interaction with the software. With parental consent, sessions are video taped to allow researchers to gather additional data. The configuration of the test room follows one of 3 configurations (Figure 3).

From these sessions, research will attempt to determine not only whether these forms of feedback can encourage sound, but also explore other related behaviors of children with

ASD; is there a form of feedback (auditory or visual) that is more influential, what type and amount of attention will a child pay to the screen on a computer, are children with ASD visual learners, and are all children with ASD the same (in terms of preferences).

Figure 2. A child using a spinning visualization with echoing auditory feedback. His eyes are looking at the screen.

Phase One began in early August 2007, and was completed in November 2007. Initial qualitative results appear promising. Qualitatively, many of the children appear to have forms of feedback for which they will generate far greater number (and frequency) of sounds. In addition, many parents have expressed that their children become excited, if not elated when they realize that they are coming to a session. That could indicate that the visual/ auditory stimulus is enjoyable to play with and thus could be used as a form of enjoyable education for children with ASD.

Figure 3. The room for phase 1 was configured based on the needs of the child. If the child had not learned to sit, the room was opened up (left) and a trampoline and/or bean bag chair was used while the visualizations were projected on a screen. Children who learned to sit, but preferred the large screen were placed in a chair surrounded by tables (middle) to help confine their movements and to encourage focusing on the screen. For the remaining children, a large screen computer was used (right), with a chair restricting their focus to the screen. For the first 2 set ups, a speaker was placed behind the projector screen. For the table-top computer, the speaker was placed behind the monitor.

One specific child appears to be reacting over and above the others in terms of sound production. Specifically, he appears to be exhibiting signs of turn taking (with the auditory feedback), as well as mimicking many of the sounds generated (as if playing a call and response game). At the completion of his standard 6 sessions, we are planning to conduct an additional 2 sessions with a new visualization (controlled through a wizard of Oz technique) that requests that the child make specific sounds. Should those sounds be made, visual and auditory reinforcement will be provided. The choice of reinforcement will be based on the qualitative observations of the child's preferences made by researchers. Should the results prove positive, we will have an indication that these systems (with little modification) could be used to teach sound formation to some children with ASD.

Analysis

For the quantitative analysis, we plan to treat Phase One as a single subject analysis across conditions with auditory and video recordings of the following variables: time in chair, percent of intervals with positive emotive state, diversity of phonetic repertoire, frequency of utterances, variation in utterance duration, and exploration of utterance volume. Though we plan to focus primarily on within subject comparisons, we plan to do some across-subject analysis.

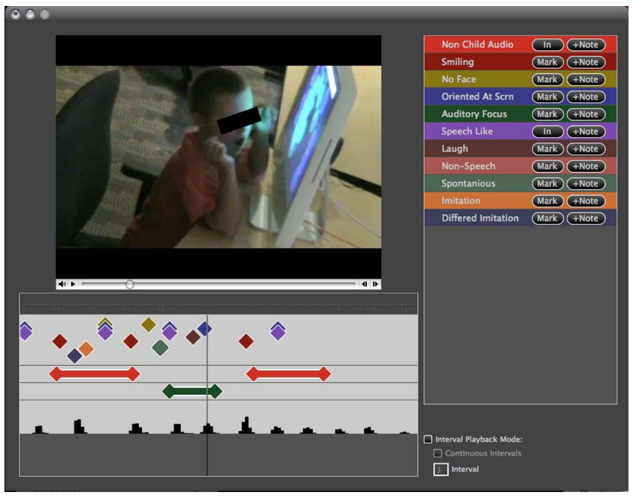

Figure 4. To aid in the video analysis, we are creating a new tool to help facilitate video coding, Vcode. Vcode is designed to facilitate multiple ways to analyzing, and annotating video. Data collected with Vcode can be synched with existing comma delineated data files to create a unified data set. Further, to help determine reliability, Vcode will perform agreement analysis on data collected by multiple coders.

Further studies are planned exploring the effect of visualizations on vocalization frequency, controlling vocalization, instructing children to make specific sounds, and word formation. We also are planning to explore form factors ranging from larger objects to portable hand-held devices (which would allow children to learn outside of an office, in more comfortable environments like the home).

Conclusion

To date, little or no research has been reported on using technology to teach low functioning children with ASD to learn to vocalize or speak. However, the field of augmentative and alternative communication embraces technology primarily as a medium of communication and not as often as a method of instruction. If we can encourage vocalization at the age of 3, a pivotal age for children with ASD, this could lead to an increased communicative ability, which makes not only the child's life easier, but also increases their chances of functioning in the world around them. In addition, if the approach we are recommending proves successful for speech, similar methods could be applied to other behaviors or to other disorders with speech impairments.

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About the author

Joshua Hailpern is currently a Ph.D. student at the University of Illinois at Urbana-Champaign in the Computer Science Department focusing on Human Computer Interaction. He attended Carnegie Mellon University in Pittsburgh, graduating with a BS in Computer Science and a minor in Music Technology. His dissertation focuses on developing new technology to help teach lower functioning children with autism how to speak and utilize spoken language as a form of communication. He is working with his advisor, Karrie Karahalios as well as Professor James Halle from the Department of Special Education at UIUC and Laura DeThorne from the UIUC department of Speech and Hearing Sciences. Website: http://hailpern.com/joshua/