yCAT website provides interactive communication experience for young children: Phase 3 usability testing

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INTRODUCTION

Children with many diseases and disorders of development often have considerably intact cognition. However, muscle weakness, atypical body structures, and neurological differences can limit participation in meaningful activities including mobility, environmental access, play, and communication. Communication is vital to children's healthy development, as it allows them to express thoughts, feelings, and share information; each of these functions contribute to learning and social participation [1]. Augmentative and alternative communication (AAC) devices are used by school-aged children with communication difficulties [2,3], but there is limited evidence on the effectiveness and availability of assistive technology devices for children five years and younger [4], particularly those with complex communication and mobility needs.

In response, a multidisciplinary team of healthcare practitioners and computer scientists collaborated with community members who have or support children who have complex communication and movement challenges. This group worked together to assess the need for an AAC system targeting young children age 2-5 years [5]. From this partnership, we developed yCAT – the Young Children's Assistive Technology system. We have completed several phases of testing of this multi-modal product, including individual pilot cases, usability testing with typically developing children, and clinical testing with children with communication challenges who do not have physical/mobility limitations. Ultimately, our goal is to answer the question: can wearable computer based assistive technology be used to increase communication and provide environmental and mobility device control for young children with complex movement and communication needs? This paper reports on our most recent phase of study, and a discussion of next steps for yCAT.

YCAT WEBSITE

yCAT is a web-based assistive system designed for young children (2 to 5 years) with communication difficulties. It was developed as a platform-agnostic website which can be easily accessed by any computer devices including regular PC and mobile devices such as tablet and smart phones. yCAT uses visual icons and text-to-speech technology to help young children understand daily activities and learn to communicate with others as well as express their needs and feelings. In order to make the functions and options easier to understand and engaging to the target user population, all the icons of the application are kids-friendly images with consistent artistic style. Moreover, all the icons are accompanied with both textual label and corresponding audio description, allowing young users to understand the function or option even though they are not able to read the text.

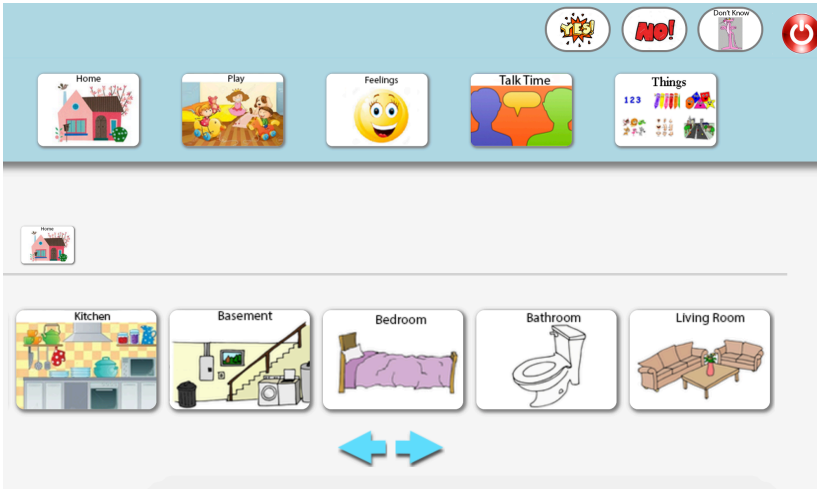

Figure 1. A sample webpage of the yCAT website illustrating the first five level content categories including home, play, feelings, talk time, and things, and the next level icons within the "home" category.

The daily activities and communication needs that yCAT supports are grouped into five categories including "Home" "Play", "Feelings", "Talk Time" and "Things". Both the selection of the content items and the information architecture of the website had undergone multiple iteration based on the feedback from the healthcare practitioners and the caregivers of children with special

needs. Figure 1 illustrates the navigation and page design of yCAT. The five first level content categories are listed at the top of all pages so that children can easily move back and forth between categories. The parent categories of the current page are listed in sequence at the top right corner of the page right below the first-level content categories. Children can click the icon of any of the parent categories to go back to that level.

METHODS

The purpose of the current study was to gain qualitative information on the utility, usability, learnability, memorability, and user satisfaction with the yCAT website. We worked with four young children, ages 2-5 years old, who were attending a University-affiliated therapeutic preschool and had a documented diagnosis of expressive or mixed language delay/disorder. Results are presented as a qualitative case series.

Children completed three testing sessions. In the first, children were oriented to the yCAT website on an iPad and provided demonstration and hand-over-hand assistance, which was faded as the child completed three basic communication tasks. In the second session, children were reoriented to yCAT, and asked to attempt to complete the tasks independently. In the third session, children were observed while engaging in free play/device use as desired, and supported as needed. Data were collected using (a) videorecordings of the sessions, (b) field notes of clinical observations (such as the child's engagement, affect, level of assistance required, expressed interests, and contextual factors), (c) caregiver feedback, and (d) analytic data from the website database, such as path/efficiency, number and speed of clicks, item selection, etc.

RESULTS AND DISCUSSION

The main purpose of this phase of research was to determine usability aspects of the yCAT system website, which was designed to enhance communication for young children (ages 2-5 years) with speech language delays. Data were analyzed using a mixing table to compare and synthesize multiple sources of information and generate themes, which included (a) factors related to child engagement, (b) interface issues, (c) interest in iPad device and yCAT website, (d) carryover/learning effects, and (e) recommendations for improvement.

The amount of assistance provided to the child users decreased with each consecutive session, and both occupational therapy researchers and caregiver supported as appropriate. Below is a brief summary of each child's performance during the trials:

Child 1 engaged with yCAT effectively and appeared to make connections between adaptive communication and real life applications. For example, he touched the "hug" icon and held out his arms for a hug. He was agitated and uncomfortable without his mom present. Child 1 enjoyed locating the icons and requesting car and train toys in the "choose play" area of the website. He was most engaged when using the yCAT website paired with an Amazon Echo Plus device to turn on the light. He did not find any targeted icons upon request, but engaged and explored independently.

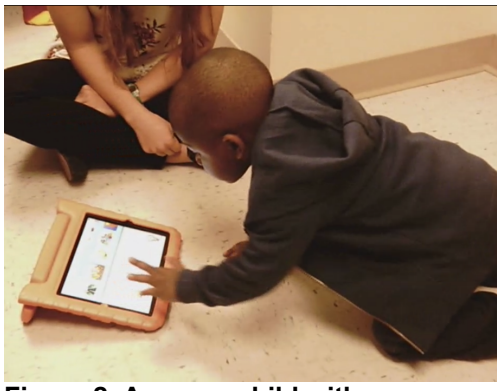

Figure 2. A young child with expressive communication challenges uses the yCAT website on an iPad.

Child 2 was initially uninterested in the yCAT website. He repeatedly exited the website and tried to find YouTube videos. His father used positive reinforcement, providing hand-over-hand assistance to press "goldfish" then handed him a goldfish cracker in an to attempt to make connections between using yCAT for communication. Child 2 exhibited improved engagement over the course of the sessions, but did not independently use yCAT to attempt communication. When using the iPad for free play, he scrolled through and selected videos on YouTube independently.

Child 3 was initially disinterested in the yCAT, but gradually gained interest. He was able to navigate the website and complete most tasks with verbal cueing only. Although his mother, who spoke to Child 3 in his native language, tried to help facilitate his engagement with yCAT, the presence of his little sister in the testing area was distracting. He exhibited light touch which sometimes was not registered by the iPad/website.

Child 4 was highly engaged with the yCAT website. She was able to learn procedure and complete targeted tasks independently. She was motivated and drew connections between images and actions, such as touching the "brush teeth" icon and then imitated brushing her teeth.

All children reported enjoying using an iPad and had prior experience with the device. This resulted in generally appropriate touch patterns and successful navigation, similar to [6].

The level of understanding and "success" with each item requested varied among participants. Turning the light on and off using the website paired with an Amazon Echo Plus device was the item that the participants responded to most positively. This finding coincides with previous studies [e.g., 6,7], which suggest that positive reinforcement should be used as a principal motivating technique when learning AAC.

Throughout the data collection process, researchers observed design aspects of the website that may have inhibited the children's performance, including a longer than expected response delay (due to poor Wi-Fi signal), repetitive audio "stuttering" as a result of the child making multiple selections during this delay, sporadic magnification of the screen, poor image resolution, images that did not hold meaning/represent the intended item to children, and excessive number of clicks/levels required to find specific items.

The level of engagement with the yCAT website varied between children, but several contextual factors during each session likely led to much of this variability. Contextual factors that may have affected child performance include distractions or family in the room as well as the child's unfamiliarity with the environment.

Via a post-program survey, caregivers praised many features of the website and emphasized the potential of the yCAT website for helping their child to communicate more independently. There was also positive feedback associated with the general accessibility of the yCAT website, the wide variety of included categories, and connections with smart home technologies. However, several noted that it could be more efficiently and intuitively organized, and others reported that they did not particularly like the voice and phrases that were associated with the images.

CONCLUSIONS

Caregiver feedback matched the observations of the researchers and the thematic analysis, and has been useful in making post-study changes to the website, including (a) reorganization and simplification of levels, (b) conversion to a mobile application to enhance design/user interface, (c) modification of images to better represent child preferences, and (d) amelioration of technical glitches such as delay and resolution problems.

We are currently studying how children without physical limitations use yCAT to communicate in the home environment, and the extent to which using yCAT in the home influences young children's engagement in meaningful activities. We hypothesize that children will use the yCAT app to request desired items, to answer questions, to initiate conversations, and engage in play and other occupations of development. We believe that using the yCAT app will also lead to improved social closeness with family members and decreased communication-related frustration for both the child and family members. Our ultimate goal is to pair the app with a customized, wearable switch-access system and a range of smart home devices and sensors embedded in the user environment to enable even greater independence for young children with complex physical and communication challenges. In combination, our results to date demonstrate the relevance and promise of yCAT to enhance communication and participation for young children.

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