GenAAC: Augmentative and Alternative Communication System for Generalization Skills in Children with Autism

Ryan Petersen
Drexel University
rdp65@drexel.edu

ABSTRACT
There are many Augmentative and Alternative Communication (AAC) systems available ranging from simple to complex. One main complaint is that the pictures are line drawings or cartoonish - not real images. Also, many of these devices are quite cumbersome and large and make a child with disabilities attract attention when out in the community. This proposed communication application displays real pictures that rotate through several pictures of the same item. For example, if the child had a "cookie" on their device, it would rotate through real world images of a chocolate chip cookie, sugar cookie, and gingerbread cookie. Not only would this provide an opportunity for the child to communicate a want or need, it would also help him/her generalize the word, working on two skills simultaneously. Additionally, since it is a computer application, pulling out a small laptop would be more socially appropriate compared to using a specialized device. This application has three different ranges of usability, depending on the cognitive level of the student, which would be set by the teacher or speech-language pathologist before use.

Author Keywords
Augmentative and Alternative Communication; Assistive technology; autism; child-computer interaction

ACM Classification Keywords
K.3.1 [Computers and Education]: Computer Uses in Education; K.4.2 [Computers and Society]: Social Issues-Assistive technologies for persons with disabilities

INTRODUCTION

Augmentative and Alternative communication is any and all communication, besides oral speech, that is used to express needs/wants/ideas. This includes facial expressions, gestures, pictures, writing, etc. From the American Speech-Language Hearing Association (ASHA), "People with severe speech or language problems rely on AAC to supplement existing speech or replace speech that is not functional. Special augmentative aids, such as picture and symbol communication boards and electronic devices, are available to help people express themselves. This may increase social interaction, school performance, and feelings of self-worth."[8]. Speech-language pathologists work with children and adults to help develop their speech and, in cases where they are unable to use their speech, alternative communication. This can be both unaided communication systems, such as body language or sign language, or aided communication systems, such as paper and pencil, speech generating devices, or electronic communication devices. This paper will focus on Aided communication systems specific to children with developmental disorders, most notably Autism.

Autism spectrum disorder (ASD) affects around 1 in 150 children[5]. Children with autism tend to suffer from social impairment, communication difficulties, and repetitive and stereotyped behaviors. Typically, normally developing toddlers should be able to display wants and a few words by their first birthday. This is delayed in children with autism. As a result, many children with autism learn to communicate using pictures[9].

Picture exchange systems are used widely among speech-language pathologists as they are a preferred way of introducing alternative communication to a child with autism. These systems often have multiple layers or stages that a child can progress through as they become more cognitively advanced with their understanding of the communication system. Picture exchange systems vary in terms of layout but ultimately try to provide a child with the same layer of understanding of a picture exchange system. Common systems today include PECS[7], Dynavox[10], and TapToTalk[11]. The main complaint some speech-language pathologists have is that the pictures used in each of these systems are drawings. Children with autism may associate an action with a picture but may not be able to recognize it in real world due to the cartoonish nature of the associated picture. My proposed AAC system does not revolutionize the way picture exchange systems are implemented, as it has already been seen that such systems are very effective[13]. It will instead replace the cartoonish pictures that other systems associate to actions with pictures from the real world. This system will support development of communication, social skills, independence, and all of the same developmental areas that currents systems strive to shape. Additionally, it will develop one skill that none of these areas hit, generalization. Generalization is a crucially important skill that teaches children with autism, for example, a car is a car, no matter if it's blue or red, or an SUV or a sports car. [15] Through the use of rotating real world pictures, children with autism will better develop that essential skill which can increase their development into a functioning member of society. My application hopes to be

the stepping stone to further development of applications to help those with special needs and to give them a voice in society.

PREVIOUS WORK

There are many different AAC systems in use right now. By far the most widely used is PECS[7], or Picture Exchange Communication System. PECS was developed in 1985 by Lori Frost, M.S., CCC-SLP and Andy Bondy, Ph.D. It is an inexpensive and simple system that uses picture symbols to teach children to communicate and hopefully develop speech. There are 6 phases involved it the PECS Protocol: I. How to Communicate, II. Distance and Persistence, III. Picture Discrimination, IV. Sentence Structure, V. Answering Questions, VI. Commenting. PECS has been found to be a very effective system, with research in multiple countries continuing every year.

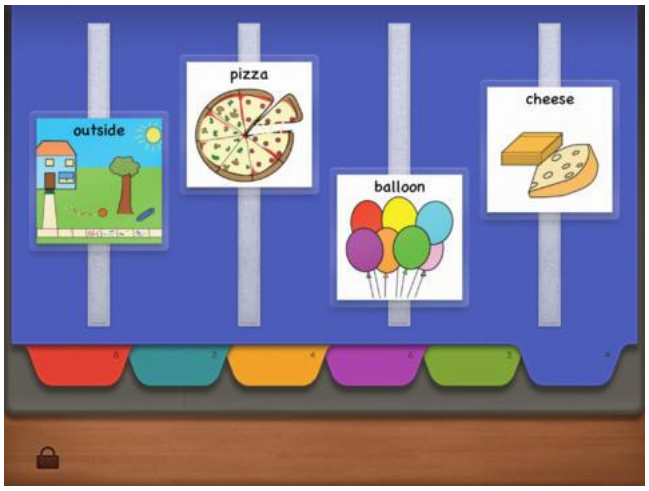


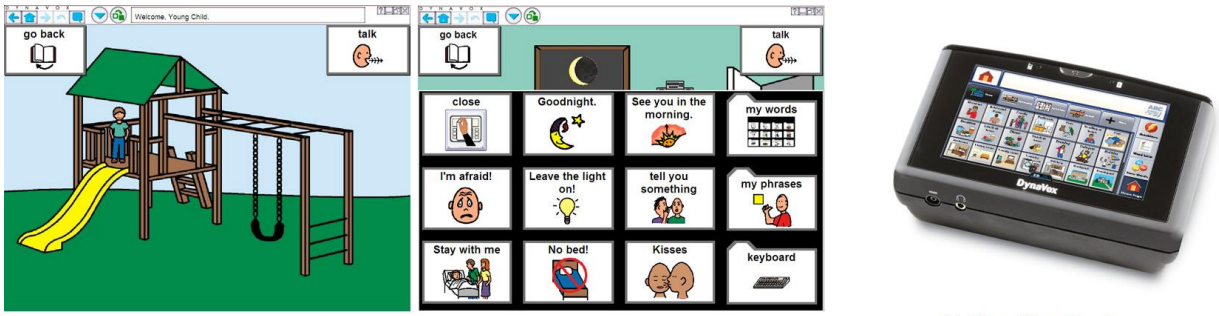
Figure 1. *PECS Phase III* app screen

PECS additionally has multiple mobile applications available through Pyramid Apps, the most popular being an iPad app that focuses on phase III of the PECS protocol called "PECS Phase III" (Figure 1). According to the PECS website the app is intended to "serve as an aid to practice discrimination techniques and strategies with one or several learners within a single lesson. Touching the correct icon will result in immediate visual and auditory feedback from the device in a manner far quicker than a teacher could react. If the learner touches an incorrect icon, there is no significant feedback. A correct picture selection results in access to a desired item or activity"[7]. These are all effective applications that supplement an equally effective system, however they fail to address generalization due to their use of cartoons and drawings. These symbols are effective when in use in a school setting, but could be quickly forgotten when a child is placed in a real world setting.

DynaVox[10] is a Pittsburgh, PA based company that is the leading provider of AAC devices and software. DynaVox distributes physical speech devices loaded with their proprietary InterAACt software which uses Picture Communication Symbols(PCS)[14] to facilitate communication. This software tries to give a child more real-life communication by presenting them with virtual, real world situations. DynaVox suffers from the same problem as PECS where it uses cartoons and drawings for pictures, and the "real-life situations" is presents are drawings of fast food restaurants and cartoon playgrounds (Figure 2a). Additionally, DynaVox distributes their own speech devices which resemble tablets (Figure 2b) but can be quite large and obvious. If a child were to pull one of these out in a social situation it would be obvious that the child was using an AAC device.

TapToTalk[11] is an app that is popular among parents. The basic app is free and is available on the iPhone, iPad, Android devices, Windows PCs, and a bevy of other platforms. It uses pictures to communicate much like other AAC platforms. TapToTalk provides the child with some ambiguity due to the fact that this application can be used on devices that everyone has. That and the fact that it's free are surely the main reasons this application is popular among parents of children with autism. There is a customizable version of the app that would conceivably allow the user to add pictures from the real world. This, however, comes with a price. The TapToTalk Designer app costs $99.95 per year or a $179.95 flat fee. Additionally, to upload photos from your phone you will need the $1.99 TapToTalk Uploader application. TapToTalk does have a large library of images available that are a little more realistic but for the most part suffer from being cartoonish as well. Additionally, some people or professionals may be turned off by the extreme price of such seemingly non-complex software, given the cheap alternatives available. The free version of the app has a significant drop off in features, as one may imagine. The voice on this application does not sounds natural but more like a robot, once again causing the child to be distinguished as a child with a disability in social situations and offering a model of speech that is not realistic.

SymbolChat[1] builds upon the PCS system used by DynaVox's InterAACt system, by allowing users to instant message other users over the internet using over 2,000 picture communications symbols. This may be a more suitable method for using PCS as it can allow children with autism to interact with others using the symbols they may already know. However, it does nothing to teach them how to use these symbols and additionally does not teach generalization due to the cartoonish nature of the pictures and only offering one picture per word.



a) InterAACt screens

b) DynaVox Device

Figure 2. DynaVox offerings for children with autism

Other, lesser known software like AutVisComm[2] and CAPKOM[3] are similar to PECS/DynaVox/TapToTalk and suffer the same problem of cartoonish pictures and only one picture per word.

MOSOCO[4] is a mobile application that uses augmented reality and visual supports to promote social skills. MOSOCO uses real pictures to help children with disabilities interact with other children but fails to expand on generalization as it only focuses on the social skills aspect of communication.

Overall, there are many options out there for children, and many are good and effective options. All of them, however, fail to teach generalization, a key skill that children with autism need to assimilate with the real world.

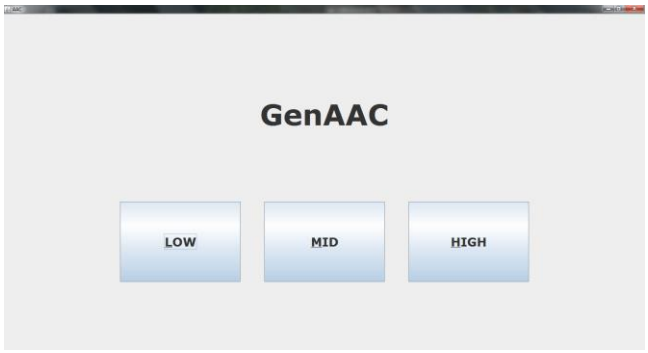


Figure 3. Title screen

SYSTEM

The program is named GenAAC, short for Generalization Augmentative & Alternative CommunicationThe interface for this program is simple and has to be that way as it is meant to be used by children with Autism. This first screen seen is meant to be used by the teacher or speech-language pathologist. It simply shows the application title and three buttons, low, mid, and high (Figure 3). These correspond to the cognitive level of the student using the application. Once chosen, the student will be able to use the device to communicate wants and needs. Other than the X button on top, there will be no way to go back to the main (first) screen.

The low level setting consists of 6 buttons: no, yes, toy, snack, drink, and bathroom. Each button has the word displayed on top and a corresponding picture underneath. Once a button is pressed, a dialog will appear displaying the word button and the desire. For yes and no the dialog will simply display the yes button or no button. For toy, snack, and drink, the dialog will display the words "I want" on top and the corresponding button underneath. For bathroom, the dialog will display "I need" on top and the bathroom button underneath. Each dialog will speak the words on the dialog using the FreeTTS Java Speech API. Each dialog appears for ten seconds, after which the child is returned to the 6 button screen. Additionally, every button will have a new image for the corresponding button after each button press.

a) Option screen

b) Dialog box

Figure 4. Low-level options

The mid-level setting requires students to string together sentences to display their want or need. There are 10

buttons that are grayed out depending on which buttons are pressed. The first button available is "I", the start of the sentence, with a picture of a child on it. After that is pressed, buttons "do not", "want", and "need" are available. The "do not" button is just a modifier to the sentence containing want or need, so only itself is disabled when it is pressed. The "want" button enables "snack", "drink", and "toy, while the "need" button enables "break", "help", and "bathroom". Once an option after "want" and "need" is chosen, a dialog will appear showing each button pressed in a sentence (Figure 6b). The dialog also speaks the words as a sentence. The dialog is dismissed after 10 seconds and the buttons are reset with new images for "snack", "drink", "toy", and "bathroom". The "want", "need", and "help" buttons display and animated .gif of the American Sign Language (ASL) word. Figure 6a shows the progression of buttons that need to be pressed in order to say "I do not want drink."

The high level setting uses the same interface as the mid level except it adds categorization of "snack", "drink" and "toy". After one of these options is selected, a new screen will appear with 6 buttons/options for that category. For example, a selection of "drink" will bring up a new screen with the options "apple juice", "orange juice", "water", "soda", "milk", and "chocolate milk" (Figure 5). Once a selection is made, a dialog will display and speak the sentence similar to that in the mid level. All behaviors for "break, "help", and "bathroom" are identical to that of the mid-level setting.

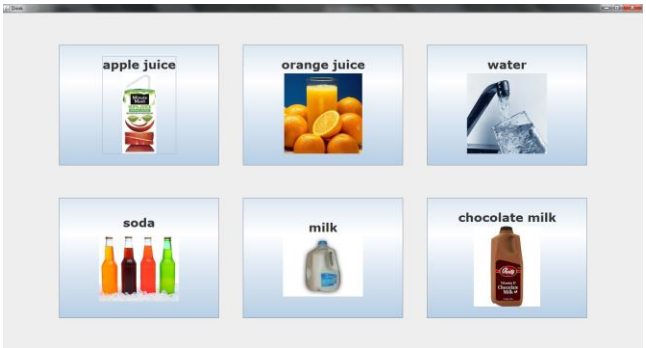
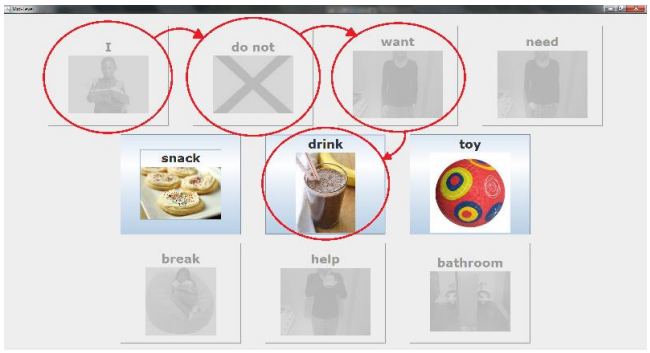


Figure 5. High-level category

The software is very simple and usable by children with Autism at all cognitive levels. The usability and intended interaction with the software is not revolutionary and is not meant to be. The main feature that changes this software from its competitors is the rotation of images. This simple feature exposes the child to category generalization. Without this rotation the child could just learn by trial and error that a certain button gets him a snack. But with the changing images, each button looks different, and the child will begin to associate each image with a category which will help them recognize those objects in the real world.



a) Option screen

b) Dialog box

Figure 6. Mid-level category

EVALUTATION

Unfortunately, I do not have the ability to test this on multiple children with Autism, as my access to them would require parent permission and volunteering by those parents and children. Instead I will be using Jody Roberts, speech-language pathologist, to evaluate the usability of the program on a 1-5 scale. Scale values are 1 being completely disagree, 2 somewhat disagree, 3 neither agree nor disagree, 4 somewhat agree, and 5 completely agree.

I let Ms. Roberts use the application for as long as she wanted but gave her no initial instruction of how to navigate the application. Afterwards, I gave her a series of questions with a section for additional comments at the end of the survey. The following is her evaluation of the program:

The application is easy to navigate for adults: *5*

The application is easy to navigate for children with Autism: *4*

The application is suitable for children with Autism of all cognitive levels: *4*

The application is child friendly: *5*

The application's Text-to-speech voice is appropriate: *2*

The application encourages generalization: *5*

The application is a suitable AAC device: *5*

The images in the application are real-life representations of the associated word: *5*

Additional Comments: *Could be difficult to use for with children with physical disabilities due to*

> *the fine motor skills needed to use a computer mouse. The text-to-speech voice sounds like a robot. However, this is a great AAC device to teach generalization and carry over skills for real world use. No other AAC device has rotating pictures to increase generalization skills. This would be a great application to use in any classroom setting for children with varying cognitive levels.*

This application is meant for use by children with autism so it needs to be very usable for children with low cognitive levels. Ms. Roberts' feedback showed that this is potentially a very usable program for such applications. Areas Ms. Roberts found the application lacking were in realism of the TTS voice and usability with children with physical disabilities. These are both areas that are agreed upon and will be areas of focus in the future work on the application. I would further like to warn the reader that this feedback has the potential to be biased. Ms. Roberts is the author's fiancé and is thus required to support and love everything the author does.

FUTURE WORK

Future work would result in porting this application to mobile platforms such as smartphones and tablets. Having this software available on interfaces that everyone uses will further allow children to assimilate into everyday society. This will also allow further use with children with physical disabilities. The application also needs improvement in the realism of the TTS voice. The current iteration sounds too electrical and it will need to sound more human to allow children to hear appropriate production of words. Additionally I would like to include the ability to upload your own photos for each category.

CONCLUSION

Augmentative and Alternative Communication applications are essential for communication development for children with Autism. They deserve the same level of iteration and improvement that other applications with broader and more marketable audiences receive. Unfortunately, they have not as of yet, and the most popular applications have decided to settle on the same cartoonish images with minimally varying layouts. GenAAC does not drastically change the way AAC devices are used. Instead, it changes the way the current generation AAC programs are designed. With real world images and animated sign language, children will be able to recognize real world items. Additionally, the generalization capabilities of the program will allow children to assimilate into everyday society better than any current system allows. Further development will be needed in order to correct issues with the TTS system and add to the capabilities of the image database. However, further development is something that should be continuously done on all AAC systems in order for us to give those without the ability to speak a voice in everyday society.

ACKNOWLEDGMENTS

I would like to thank Professor Dario Salvucci and all students who provided helpful comments on previous versions of the application. A special thanks goes out to Jody Roberts, Speech-Language Pathologist at Elwyn in Philadelphia, PA, for her insight and professional knowledge.

REFERENCES

1. Tuuli Keskinen, Tomi Heimonen, Markku Turunen, Juha-Pekka Rajaniemi, and Sami Kauppinen. 2012. SymbolChat: picture-based communication platform for users with intellectual disabilities. In *Proceedings of the 13th international conference on Computers Helping People with Special Needs - Volume Part II* (ICCHP'12), Klaus Miesenberger, Arthur Karshmer, Petr Penaz, and Wolfgang Zagler (Eds.), Vol. Part II. Springer-Verlag, Berlin, Heidelberg, 279-286.
2. Harini Sampath, Bipin Indurkhya, and Jayanthi Sivaswamy. 2012. A communication system on smart phones and tablets for non-verbal children with autism. In *Proceedings of the 13th international conference on Computers Helping People with Special Needs - Volume Part II*(ICCHP'12), Klaus Miesenberger, Arthur Karshmer, Petr Penaz, and Wolfgang Zagler (Eds.), Vol. Part II. Springer-Verlag, Berlin, Heidelberg, 323-330.
3. Andrea Petz, Nicoleta Radu, and Markus Lassnig. 2012. CAPKOM --- innovative graphical user interface supporting people with cognitive disabilities. In *Proceedings of the 13th international conference on Computers Helping People with Special Needs - Volume Part II*(ICCHP'12), Klaus Miesenberger, Arthur Karshmer, Petr Penaz, and Wolfgang Zagler (Eds.), Vol. Part II. Springer-Verlag, Berlin, Heidelberg, 377-384.
4. Lizbeth Escobedo, David H. Nguyen, LouAnne Boyd, Sen Hirano, Alejandro Rangel, Daniel Garcia-Rosas, Monica Tentori, and Gillian Hayes. 2012. MOSOCO: a mobile assistive tool to support children with autism practicing social skills in real-life situations. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '12). ACM, New York, NY, USA, 2589-2598.
5. Mirfat Akter Sharmin, Md. Mizanur Rahman, Syed Ishtiaque Ahmed, Md. Mustafizur Rahman, and S. M. Ferdous. 2011. Teaching intelligible speech to the autistic children by interactive computer games. In *Proceedings of the 2011 ACM Symposium on Applied Computing* (SAC '11). ACM, New York, NY, USA, 1208-1209.
6. "Picture Exchange Communication System." *Wikipedia*. Wikimedia Foundation. http://en.wikipedia.org/wiki/Picture_Exchange_Communication_System

7. "PECS-USA.com." *PECS-USA.com*. http://www.pecsusa.com/
8. "Augmentative and Alternative Communication (AAC)." *American Speech-Language-Hearing Association*. http://www.asha.org/public/speech/disorders/AAC/
9. "Autism Spectrum Disorder." *National Institute of Mental Health*. http://www.nimh.nih.gov/health/topics/autism-spectrum-disorders-pervasive-developmental-disorders/index.shtml
10. "Communication Devices – Speech Devices." *DynaVox*. http://www.dynavoxtech.com/default.aspx
11. "AAC Apps for All Ages, All Languages." *TapToTalk*. http://www.taptotalk.com/
12. Ali, E., MacFarland, S. & Umbreit, J. (2011). Effectiveness of Combining Tangible Symbols with the Picture Exchange Communication System to Teach Requesting Skills to Children with Multiple Disabilities including Visual Impairment. Education and Training in Autism and Developmental Disabilities, 46, 425–435.
13. Tien, K-C. (2008). Effectiveness of the Picture Exchange Communication System as a functional communication intervention for individuals with Autism Spectrum Disorders: A practice-based research synthesis. Education and Training in Developmental Disabilities, 43, 61-76.
14. "Picture Communication Symbols." *Wikipedia*. Wikimedia Foundation. http://en.wikipedia.org/wiki/Picture_communication_symbols
15. Whalen, Chris. "The Importance of Generalization." *Dr Chris Autism Journal*. http://drchris.teachtown.com/2009/06/18/the-importance-of-generalization/