A Culturally Inclusive AAC App for Children with Autism in China

by

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Abstract

Children with autism usually have problems with communication. Augmentative and Alternative Communication (AAC) tools are used to support these children. While several AAC apps are available in English, there are just two AAC apps in Chinese with culturally relevant content. Through this project, I created a prototype mobile AAC app for preschool children in China with text and audio in Mandarin and images relevant to Chinese culture (hosted at http://58.213.134.155:8888). I had the prototype evaluated by parents and caregivers of children with autism in a recovery centre in Nanjing, China. A number of suggestions for refinement were received, of which one has been implemented. I also studied the use of iPads by Chinese children with autism in Canada and China and found it to be less popular in China than in Canada. Future work plans include: (1) refinement of the app to make it usable by recovery centres and parents; (2) development of a paper PECS system for Chinese children based on the illustrations created for the app.

Keywords: Augmentative and Alternative Communication (AAC), Autism, Children, China, Culture, Inclusive Design, Vocabulary.

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I thank Mitacs Inc. for the Globalink Award, which helped me conduct onsite prototype evaluation in China. Finally, I am forever grateful to the Star Children, who provide meaning to my research.

x

Dedication

To all the Star Children (星星的孩子) of the world

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1 Introduction

Autism Spectrum Disorder[1] affects over 2 million children in China[2]. The Chinese call children with autism 'Children of the Star' (星星的孩子), because they think that these children are just like stars—shining, but isolated, living outside the society (Yuan, April 2, 2014). Exploring autism, communication, culture and technology between Canada and China, this major research project designed and developed a mobile app for Augmentative and Alternative Communication (AAC)[3] aligned with Chinese culture and language to support preschool children with autism. This was the genesis of the 'Star Child AAC app' (星孩辅助沟通系统应用). The purpose of inclusive tools such as the Star Child AAC app is to facilitate communication, relieve isolation, and integrate these 'stars' into the society.

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[1] Autism Spectrum Disorder (ASD) and autism are two general terms to denote a group of complex disorders of brain development characterized by varying degrees of difficulty in social interaction, verbal and nonverbal communication, and repetitive behaviours. (https://www.autismspeaks.org/what-autism). The term autism is used throughout this report to refer to this condition.

[2] http://gd.sina.com.cn/zs/social/2015-04-03/074623822.html.

[3] Augmentative and alternative communication (AAC) includes all forms of communication (other than oral speech) that are used to express thoughts, needs, wants, and ideas. (http://www.asha.org/public/speech/disorders/AAC/).

1.1 Context

Verbal language is a useful tool for people to understand each other. It forms the voice in our brains and helps us think. Our expressions arise out of our internal conceptions. However, for others to perceive our ideas and for communication to progress, those expressions must be understandable to others. Individuals with autism have problems with expressing as well as understanding.

Autism is a neurodevelopmental characteristic that impairs verbal communication and social interaction; it often manifests in repetitive behaviours and selective interests (Haynes & Pindzola, 2008). The number of people diagnosed with autism has been growing remarkably since the 1980s, and in 2013 there were an estimated 21.7 million people around the world with autism (GBDSC, 2015). Deficits in social interactions and communication impairments can be recognized in autistic children as early as at two years (Haynes & Pindzola, 2008). Approximately 25-61% have little or no functional speech (Schlosser & Wendt, 2008). These children do not have the passion to make a request for anything or share their experiences with others. According to

Blankenship, early and effective intervention is extremely significant for these children because it can encourage their verbal language, self-care and social skills and, sometimes, result in recovery (2012).

The Picture Exchange Communication System, or PECS, allows children with autism who have little or no communication abilities, a means of communicating non-verbally by pictures in place of words. Research has shown that PECS encourages children to learn language (Flippin, Reszka & Watson, 2010). PECS is a form of Augmentative and Alternative Communication (AAC).

AAC is not a single communication method but a term that encompasses all communication methods that do not depend on verbal or written language. AAC systems widely use pictures, drawings and gestures as symbols. These can be created using pencil and paper or with the help of technology like computers, tablets or sound output systems, so that children can easily point and show others what they need to express. Around 14 to 20 percent of children with autism communicate using AAC systems (Light & Drager, 2007; Shane, O'Brien & Sorce, 2009).

In Canada, there are several AAC apps available for autistic children. Most of them are reasonably affordable. As of September 2015, there were 265 AAC apps; 55 of them were free, 105 were priced below $8.00, and only 17 above $100.00. People can easily buy them online.

1.2 Problem

As the largest country in the developing world, China is growing at a remarkable pace in fields such as economics, science, technology and education (Xin, Lin & Xiaohui, 2010). However, the progress in supporting children with autism to help them advance towards independent living is not that remarkable. Over 2 million children in China are on the Autism Spectrum.[4] Socially, these children are still considered "different" and "disabled" and they still receive limited diagnosis and support through hospitals (Xiao et al, 2014).

In China, many theses have been written and research conducted about AAC (Rongrong, 2013). However there are no popular AAC apps in Chinese in China. Due to lack of understanding about autism in China

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[4] http://gd.sina.com.cn/zs/social/2015-04-03/074623822.html

and absence of support for children with autism to communicate with the world, such children are usually placed in special schools and not integrated with other children (Yongmei, 2015). If AAC apps can be developed for children in China or even if apps from other countries are adapted to suit Chinese culture, the support might be quite helpful for Chinese children with autism.

1.3 Design Challenge

As an international student from China in Canada, I could see how well children with autism are supported in this country compared to my own. The Inclusive Design program motivated me to take up a design challenge that met the needs of the underserved Chinese children with autism in the context of technological support for enhancing communication. I undertook a systemic comparison of the supports received by children with autism in Canada vis-à-vis in China. One point that emerged from this exercise was that Augmentative and Alternative Communication (AAC) apps available in English are not culturally suitable for Chinese children. Not only would the language be unsuitable, but also the culture, in that a picture of "noodles" would be

more meaningful to them than that of "burger" shown on these AAC apps. And, in contrast to multiple AAC apps available for English-speaking children from the western culture, such as Proloquo2Go[5] and Grace App[6], there is only one app in Mandarin created for Chinese children named Yuudee, meaning the Little Rain Drop[7]; and, as indicated in Section 3.2.1, it is not popular. Therefore, the idea of taking up the design challenge of creating a Chinese AAC app using a culturally sensitive vocabulary and relevant illustrations spoke well to my research interests and expertise in technology, illustration, design and Chinese culture.

1.4 Approach and Methodology

I adopted an inclusive design approach[8], which involved:

- *Identifying an underserved target group marked by diversity and uniqueness*: for this project it was the group of preschool

[5] http://www.assistiveware.com/product/proloquo2go.
[6] http://www.graceapp.com.
[7] http://blogs.wsj.com/chinarealtime/2015/05/19/in-china-the-making-of-an-app-for-autism.
[8] Three dimensions of inclusive design: http://idrc.ocadu.ca/index.php/resources/idrc-online/library-of-papers/443-whatisinclusivedesign.

children with autism in China in a Mandarin-speaking community of Chinese culture.

- *Designing inclusive processes and/or tools for the target group*: this project designed and developed a prototype proof-of-concept mobile AAC app for the above group by extending the design of some AAC apps available in English.

- *Aiming for a broader impact reaching beyond the target group*; the AAC app could serve not just children with autism but also novice learners of Mandarin language as a learning tool; as well, the pictures created for the app will promote Picture Exchange Communication.

The primary motivation of this project was to find a way to support the development of communication in Chinese children with autism through technology. Driven by this motivation, the two research questions for this project were:

1. How does adoption of technology to support children with autism differ between China and Canada?

2. How can an Augmentative and Alternative Communication (AAC) mobile application be developed to suit preschool children with autism living in China?

In November, 2015, I secured a Mitacs Globalink Award[9] that allowed me to work on my project in China for four months, from December 1, 2015 to March 31, 2016. The methodological steps of the project were accordingly worked out as given below:

- To explore, through literature review and environmental scan, the differences in the adoption of technology to support children with autism in Canada and China (August/September 2015);
- To design and develop a prototype mobile app for preschool children with autism in China based on a culturally relevant vocabulary (October/November 2015); and
- To evaluate and refine the prototype through two workshop sessions with parents and caregivers of preschool Chinese children with autism in Nanjing, China (December 2015 to March 2016).

Details of actual implementation of the methods are given in Section 4.

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[9] http://www.mitacs.ca/en/programs/globalink/globalink-partnership-award.

1.5 Project Outcome

The outcome of this project is a mobile AAC app for Chinese children with autism. It is called 'Star Child AAC app' (星孩辅助沟通系统应用) in Chinese. The app uses Chinese language and the vocabulary is designed to suit Chinese culture.

1.6 Report Outline

Following this introductory section, a background to the project is presented in Section 2 in the form of a review of literature around the key concepts underlying the project: autism, communication, culture and, technology leading to the development of a conceptual framework for the project. An environmental scan of popular AAC apps in Canada and China as well as use of technology to support children with autism is presented next in Section 3, from which some criteria are drawn for the design. The methodology followed in the project, both in Canada and China, is detailed in Section 4. Section 5 describes how the prototype AAC app for Chinese children with autism was developed in Canada, followed by Section 6, which details the two workshops conducted in China and how the prototype was refined based on the feedback obtained there. A reflective overview of the project is presented in Section 7 before the final Section that lists the contributions made, and future work planned.

2 Conceptual Framework

Four general observations from Section 1 on which this project is based are:

- Autism often results in communication problems;
- Communication is specific to culture;
- Technology supports communication; and
- Technology can benefit people with autism.

Four concepts that are embedded in these assumptions are: autism, communication, culture and technology. These four concepts, that form the building blocks for this project, are examined in this section through a literature review.

2.1 Autism

Autism is a complex neurodevelopmental disorder characterized by impairment of verbal language and social interaction, and manifested repetitive behaviour.[10] The causes of autism, and the role played by environment and genes, are still controversial (Chaste & Leboyer, 2012). According to the fifth edition of the American Psychiatric Association's

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[10] https://www.autismspeaks.org/what-autism/

Diagnostic and Statistical Manual of Mental Disorders 5th edition (DSM-5), Autism, Asperger syndrome, Pervasive developmental disorder not otherwise specified (PDD-NOS), and Childhood disintegrative disorder are all together called Autism Spectrum Disorder (ASD) and autism is the core of ASD as the other four problems share the similar causes or signs with autism (Lord, Cook, Leventhal & Amaral, 2000). Early intervention can help children modify their behaviour (Myers & Johnson, 2007) and the recommendation is to start as early as possible[11].

Autism affects information processing in the brain by altering how nerve cells and their synapses connect and organize. Autism is characterised by impaired social interaction, verbal and non-verbal communication, and restricted and repetitive behaviour (Levy SE, Mandell DS, Schultz RT, 2009).

Applied Behavioural Analysis (ABA) is a training aimed at changing the behaviour of persons with autism in a positive direction. It uses positive reinforcement to focus on the principles that explain how

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11 http://www.autism-community.com/education/early-intervention/

learning takes place. Providing a reward after behaviour improves the chances of the behaviour being repeated. Through decades of research, the field of behaviour analysis has developed many techniques for increasing useful behaviours and reducing those that may cause harm or interfere with learning.[12]

2.2 Communication

Verbal language is significant in many areas in our life, logic, psychology, social science, interpretation of knowledge, etc. However, around a third to a half of autistic children do not develop enough natural speech to satisfy their daily communication requirements (Noens, van Berckelaer-Onnes, Verpoorten & van Duijn, 2006). Further, it becomes hard for children to start learning language beyond age 6 (Lu, 2012).

The impairment of verbal communication is the core symptom of autism and it also impedes children's thinking and cognition (Lin, Cheng, Hunag, He & Wu, 2014). Tager-Flusberg's research showed that, when a

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12 https://www.autismspeaks.org/what-autism/treatment/applied-behavior-analysis-aba

word has different meanings in different situations, children with autism are unlikely to recognize the proper meaning based on the specific situation, and they prefer to remember the name of the word mechanically rather than the meanings of the word in different contexts (1985). They find it difficult to comprehend what other people mean, resulting in awkwardness or problem in the communication.

Communication is generally coloured by culture.

2.3 Culture

The characteristics and knowledge of a particular group of people defines their culture. This could include language, religion, cuisine, social habits, music and arts (Zimmermann, February 19, 2015). The meanings people give to utterances often depend on specific cultural contexts that might not be replicable in other cultures.

In the context of creating an AAC app for children with autism, the pictures and words used must make sense to the children and parents, and must align with what is commonly understood by the community. This is one reason why AAC apps produced in the western

world in English might not be readily usable in another culture such as Chinese merely by translating the text.

2.4 TECHNOLOGY

The International Technology Education Association, in its report on Standards for Technology Literacy published through the Technology for All Americans project, conceptualized technology thus: "Technology is how people modify the natural world to suit their own purpose… it refers to the diverse collection of processes and knowledge that people use to extend human abilities and satisfy human needs and wants." (TAA-ITEA, 2000, p. 2)

Early speech or behavioural interventions can help children with autism gain self-care, social, and communication skills, (Myers, Johnson, 2007) and even improve their language development (Blankenship, 2013). Motivating multi-media computer-based therapies have been shown to promote communication and improve learning outcomes (Silver & Oakes, 2001). Computer intervention has been shown to hold autistic children's interest for several reasons (Silver & Peter 2001). Computer systems and programs:

- can restrict choice presenting only necessary information to the child.

- are unemotional. This frees children from social demands.

- provide responses that are consistent and predictable, thus lacking human nuances they may be difficult to understand.

- provide the child with clear routines and expectations.

- can be customised to match a child's cognitive ability and their environment.

Computer programs are predictable and unemotional. For this reason computers-based tools seem to present a comfortable environment for autistic children. Furthermore, because computer programs do not tire (i.e. they are infinitely patient), autistic children can remain focused on the programs without negative social repercussions.

The development of digital devices like iPad and iPhone have largely solved the limitation of paper based pictures systems that were bulky and difficult to carry around. Digital solutions also make it much easier to add new pictures. In paper-based systems, it is not easy to customise pictures according to need (Yee, 2012).

2.5 The Framework

Figure 1 illustrates the conceptual framework for this project as derived from the four concepts discussed in this section: autism, communication, culture, and technology. They have a tight relationship with each other. Views about autism, technology and communication are dependent on culture.
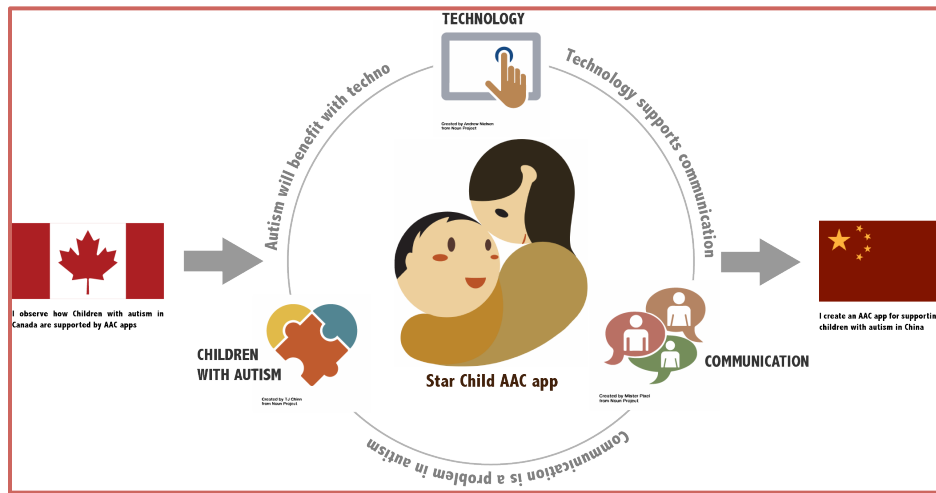
Figure 1: Conceptual framework

In the next section, some English and Chinese AAC apps are reviewed; and the use of technology in China to support children with autism is examined.

3 Augmentative and Alternative Communication

Augmentative and Alternative Communication (AAC) is an umbrella term for all communication methods that do not involve speaking or writing,[13] such as the Picture Exchange Communication System (PECS) and American Sign Language (ASL). As seen earlier, people having language or speech impairment such as autism can use AAC. In Canada, there are several AAC apps available for autistic children. However there are no popular AAC apps in Chinese in China.

The Picture Exchange Communication System (PECS) has a well-established research base and graphics are more useful to people with autism for communication than text (Sennott & Bowker, 2009). PECS is simple and cheap to access and can be used in different ways. For example, children exchange single pictures for what they want; children can use several pictures to structure sentences; children also use the sentences to answer questions or make comments. PECS contains different contexts that include many different pictures. PECS can be

13 http://www.asha.org/public/speech/disorders/AAC/

used to facilitate communication with/by people with autism and help them learn language (Flippin, Reszka & Watson, 2010). PECS is also widely used by preschool children and parents (Overcash & Horton, 2010).

The predictability of computers and the understandability of images when combined together, enable the creation of various Alternative and Augmented Communication (AAC) applications that run on different devices. For example, Proloquo2Go can run in both iPad and iPhone. The use of symbols to receive and express to communicate is also the origin of Proloquo2Go (Sennott, & Bowker, 2009). Sennott & Bowker have shown that people with autism prefer using symbols to make a request (2009).

3.1 AAC Apps in English

An English language AAC app, Proloquo2Go and a Chinese app, Little Rain Drop (小雨滴) inspired me to take on this project. These apps are reviewed and compared in the three sections that follow.

3.1.1 Proloquo2Go

Proloquo2Go® (P2G) is a popular AAC app that supports children with autism to communicate with pictures. It is mentioned in many theses and papers. The vocabulary in P2G includes both images/photographs and text. There are also numbers, letters, punctuation and space for children to select. The app also speaks out what children type. Users can upload new images and edit descriptions. P2G is also highly customizable. Under Settings, for example, there are three options to choose from: 'only image', 'only text' and image and text'. The number of images that can be chosen for display on the screen at a time ranges from 9 (3x3 grid) to 144 (9x16 grid). Colours, outlines, and size of folders can also be edited. Multiple choices are provided for background colour as well. Other settings include 'grammar', 'prediction', 'interaction', 'privacy', and 'backup'. Figure shows a screenshot of P2G. It helps children create sentences and communicate using pictures. The words and spoken text serve to help those who want to learn to communicate verbally.
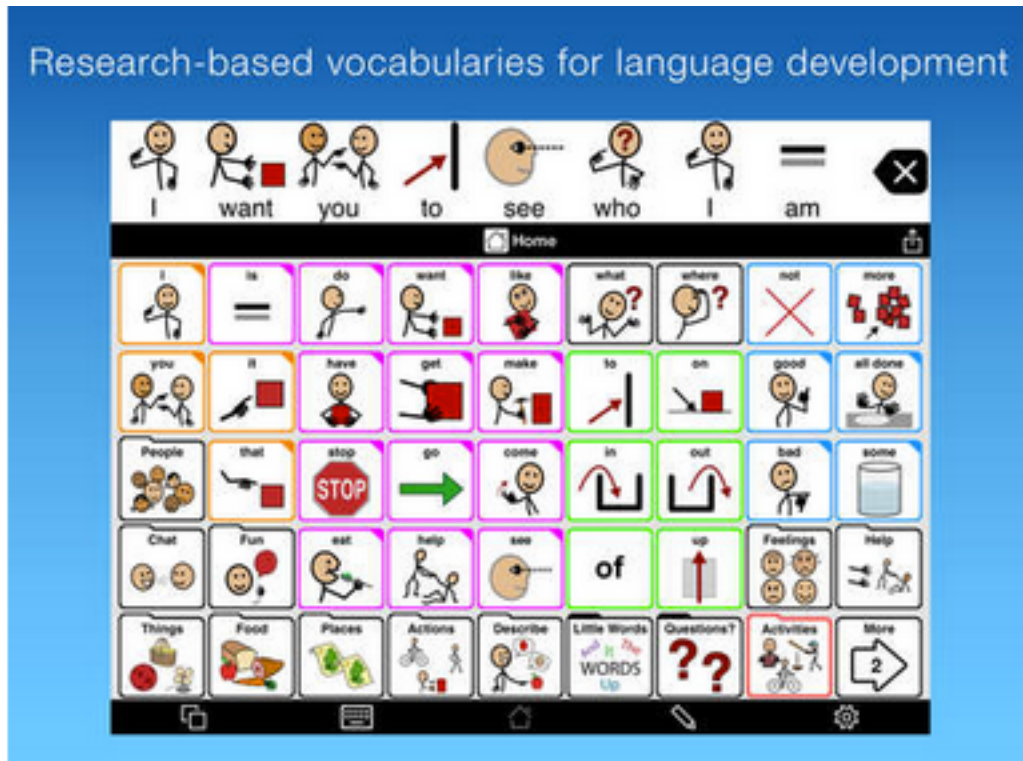
Figure 2: Screenshot of Proloquo2Go[14]

Spoken text is available in English and Spanish languages with different accents, such as English (US), English (Australian), English (UK), Spanish (NA), and Spanish (Spain). Several reading voices across genders and ages are provided. As also voices of characters, such as artificial child voice, cow boy, little creature, bad guy, sad voices, happy voices, voices from afar and up, close by, and so on.

The P2G app is rather expensive. As of March 2016, its cost at Apple's iTunes store was US $249.99.

3.1.2 Grace App

Grace App (GA) is designed for children with autism or speech delay. The founders of GA, Lisa Domican and her husband Bill, built it for their daughter Grace (and also their son) both of whom are severely autistic. The app costs US $39.99 on Apple's App store online.

The interface is simple, with listed pictures occupying most of the screen and a blank bar at the bottom to put selected pictures. It is really like an electronic version PECS, in allowing the user to choose pictures from different categories and list them elsewhere. There are only two levels of the app, a page for the categories and after clicking on a category, a level for all the items of that category. People can add new pictures by taking photos or choose from the album. People can also delete and rename the pictures.

There are several categories like colours, food and places. There are some necessary words for making simple sentences. There is a big difference between Grace App and most of the other apps for children

with autism such as P2G; it does not contain any audio or recorded voice. The founders' argument for this design is that, with easy access to synthesized sound, children might not be motivated to make an effort to speak. Use of only pictures and no sound would require them to explain and hence to practice their language.

3.1.3 Comparing Proloquo2Go and Grace App

I worked with both P2G and GA on my iPad to understand their features. I found P2G to be much more complex to use than GA. P2G is highly customizable, with too many functions, layers and icons. Some functions can control the very details of the app, such as each picture's background colour, or a bunch of options for people's voice. However, I do not think all of those functions are necessary for children with autism to use the app to help them with communication. For example, sometimes, the picture folder contains more folders inside. This could make it difficult for children to remember where the pictures are. What is more, the icons in the P2G are smaller than the ones in GA, and small icons make the screen look busy and make people nervous.

Another point of difference is that the icons in P2G are not always meaningful without the subtitle. I often had to click on it to see its use. These features made me feel anxious while using the app. GA avoids this problem by using icons that are common in people's minds. Moreover, it does not have too many icons or functions in it. The number of pictures in GA is much less compared to P2G.

GA affords more freedom to children as P2G has too many rules to follow, which makes it a bit overwhelming to use. Parents might have to teach children a lot about how to adapt to this app. On the flip side, while P2G has a wide variety of pictures, GA requires users to upload their own set of pictures. While this could involve more work, it would, at the same time, make the user feel closer to the app due to a sense of ownership and agency over many of pictures. GA seemed to me more like an app that allows children to store and edit their own photos.

3.2 AAC Apps in Chinese

I found two Chinese AAC apps: Little Rain Drop (小雨滴) and Communication Accompanies You (语你同行). However, I did not find these apps being used by either of the two recovery centers I visited. The

families I met at the centres had also not heard of the two apps. I used the two apps and a review is presented in Sections 3.3.1 and 3.3.2 respectively.

3.2.1 LITTLE RAIN DROP (小雨滴)

The Little Rain Drop (LRD) AAC app is the only Chinese AAC app in Mandarin[15]. It was released free of cost on the Apple App store in April 2014 and on Google Play store in May 2015. It was the result of a collaborative project of several big universities and institutes: Peking University's School of Life Sciences, National Institute of Biological Sciences，App China, Inway Design, and G-Wearables Design, with a $30,000 grant from the UNICEF Innovation Fund.

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[15] http://blogs.wsj.com/chinarealtime/2015/05/19/in-china-the-making-of-an-app-for-autism.

Figure 3: Little Rain Drop – Chinese AAC app[16]

However, the uptake appears to have been minimal, as there are
only two comments on Google Play, none on the Apple iTunes store

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[16] Image source: http://blogs.wsj.com/chinarealtime/2015/05/19/in-china-the-making-of-
an-app-for-autism.

and very few online evaluations or public feedback (Gu Xiaobo, 2014.04.01).

Figure 4: Settings screen of Little Raindrop Chinese AAC app[17]

I downloaded the app and tried it. The app allows the user to customise the pictures to one of three styles of display: 'No animation', 'Magnify' and 'Magnify and rotate'. The option of animation to present each item is a good idea since, sometimes static pictures might not be not able to represent a child's needs as effectively. Animation presents

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[17] Image source: ChinaByte http://net.chinabyte.com/92/12906092.shtml

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multiple perspectives of a picture, enabling the viewer to understand its meaning better. The app's interface is clean and organized. Each item is put on a wooden board with shadow underneath to make the board look realistic and more easily recognizable.

One drawback of the app is that moving from one vocabulary category to another is cumbersome. At one time, only one category shows up on the interface. To navigate to another category, the user has to select the edit option and then choose the proper category. Upon returning to the main screen, the new category will be the only category available for use. Selecting the edit function is also tricky to manoeuvre. The user has to touch the three corners of the iPad at the same time, which might not be for people with small hands. That having been said, the edit function key is designed that way to avoid getting triggered through children's touch.

The help icon to click for users to know how to edit pictures is not well designed. I could find the icon because it was the only clickable place on the screen other than the AAC vocabulary; but I do not

approve of the design of this icon. The app also allows people to add new picture and record audio.

LRD uses meaningful animations, audio and words to help children understand and communicate. LRD has both iOS and Android versions. Many smart phones and tablets can use it. It is designed for Chinese children with autism to facilitate their communication and understanding. The app is in Chinese language and reflects Chinese culture. It offers necessary sentences for use in daily life. The sentences are grouped into 40 categories, such as 'Need Help', 'Emotion', 'Question', 'Food', 'Number' and 'Shapes'. Each category has several cards with pictures and descriptions. Upon clicking any card, the picture will be displayed in the center of the screen in animated form, accompanied by audio in a boy's voice. There are different forms of audio: question, description, expression, and so on. Children can use them to answer or ask the question, make a request, or express themselves. Children could also learn to talk or understand life and society.

As far as I can see, LRD has two merits. First, the meaning of the animation is very clear to children. Animations have a longer time to express their meanings than static pictures. Also, pictures that keep changing can be more appealing to the children. Second, the design style of the animation looks quite naïve and simple, like children's style. This feature could make children feel close to the app.

However, there are also drawbacks. First, the menu of categories is not listed on the main screen but remains hidden in the edit tool, making it difficult for users to discover that other categories are available, and also to move between categories. Another problem I experienced is that the function to record sound or voice sometimes triggers the app to shut down.

To sum up, Little Rain Drop AAC app is attractive and easy to use. The content of its pictures is also close to children's life. However, no user testing result or public feedback can be found online. The app appears to be an academic project that lost its life once the funding died.

3.2.2   Communication Accompanies You (语你同行)

Communication Accompanies You (CAY) is a Cantonese app aligned with Hong Kong culture, with a Mandarin language option. The app was developed by Heep Hong Society[18]. It is a prominent institute of children's education and welfare in Hong Kong with 29 affiliates, providing multiple training and education to preschool children aged 2-6. It is created to help children with communication and fit them into society.

The app is very close in structure to PECS. It lists different categories of pictures like 'Food', 'Action', 'Toys', etc. The list is displayed on the left side of the screen and the pictures on the right side for children's selection. The top of the screen has a blank space, where the selected pictures get lined up; these are then read together by the app.

The advantage of the app is that it is an electronic version of PECS. This means that children who have worked with PECS can adapt to CAY easily. And it has more advantages than a paper PECS. CAY can

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[18] http://www.heephong.org.

store more cards without adding weight. Its reading function can have the stimulation of sound. Children can hear, remember and repeat the sound to practice their speaking. The drawing style used for the pictures is realistic. This could be helpful to children, because an abstract picture might be hard to recognize. As was the case with LRD, there was hardly any feedback available online about CAY.

Another AAC app from Hong Kong is called 語你同行 (Wish communication always be with you). It offers both Traditional Chinese language and English language. I did not find many evaluations or feedback online. I tried it out. The way it works is like Proloquo2Go: click on pictured to form sentences; categories are presented as folders; click to access different items. I could not open the settings function on my iPad.

I found yet another AAC app called Star Words (星星话). But it is very underdeveloped. One public feedback read thus: 'Wish no more people get to know this app. I think the app will only have a bad influence on children and won't educate them.' (Xu Huilin, 2014.11.03) And this comment earned several supporters. Other comments about

this app also did not show positive aspects. There are no reviews for the app on the Apple App store.

3.2.3 Comparison of Little Rain Drops and CAY

Although both Little Rain Drop (LRD) and CAY the apps feature pictures and sounds, they help children with autism in different ways.

LRD is more likely to help children perform their daily life communication, but it does not promote their ability to form sentences. The app provides fixed sentences to use and there is no space and necessary vocabulary for children to create sentences. Thus, although children can use, listen and practice the fixed sentences by repeating them, they are unable to make sentences by themselves. CAY, on the other hand, encourages children to create sentences by themselves; it does not offer any prepared sentences. This, however, requires children to have some basic language skills so that the 'make sentence' function can be useful for them.

The target users are also different in the two apps. LRD is suitable to younger children who have weaker language ability than CAY. First,

as mentioned before, to use the 'make sentence function' of CAY, the user must already know the language. Secondly, the picture style of LRD seems to suit little children better. The style of LRD is very natural and naïve, none of the picture tried to be fine. Ink is used to create the linear, and then filled in with wax crayon, which is very normal material to children. And the author of the picture did not limit the color into the linear, sometimes the color just goes out of it randomly, like what children would do during the painting. Comparatively, the style of drawing of CAY is quite mature. It is manifest that the author has some experience of painting. The structure of people or object is comparatively accurate. The content are also not flat, they are made to be three dimension. There are highlight and shadow. Most of the pictures even have great details.

To conclude, both of the apps have their own merits and deserve study: concerning drawing style, the functionality in making sentences, pictures to enhance understanding, the option to add new photos through connecting a camera and the recorder to the device. This also

provided me with ideas to consider for the prototype of my own AAC app.

From the above, outlining the problems with the currently available apps, it becomes evident that an efficient and easy to use AAC app is needed in China.

3.3 Use of Technology for Autism in China

Although initially the prototype app was conceived for development to run on an iPad on the lines of Proloquo2go, research on the adoption of iPads by Chinese children was simultaneously undertaken to find out how popular it is among Chinese children with autism and what other devices are popular. The purpose of the research was for making a decision about the platform of development of the prototype that will be taken to China for review by parents and caregivers of children with autism as well as to inform future research.

In a popular survey called 'What do you want most?' the first choice of 44% of children's is 'Electronic devices'. Since the release of the iPad, it is becoming increasingly popular among children In China.

In my personal life, I have observed iPads getting progressively more popular among Chinese children. I have seen that children love to play with iPads. My nephew and niece each have their iPad and play by the table during family dinners. Some children play in the bus on their way back home from school. Various apps on iPads have touched a variety of areas of children's lives, such as: Education: Children learn Chinese characters through games on iPads (Wang, Ji, Zhang, & Sun, 2010), and Leisure: Children read picture books through iPads (Yang, Shi & Sun, 2014).

Some Chinese research papers have been published about the use of iPads among children, both with and without disability, such as, 'A research of the adoption of iPad among preschool children' (Dai, 2013) and, 'A case study of proper selection of the iPad apps for the education of children with paediatric cerebral palsy' (Tang, 2014). These papers indicate that use of iPads among Chinese children might not be very low. On the flip side, they also mention that the iPad's screen could affect children's eyes. Since the pupils need to dilate and contract often to adapt to the change of lighting on the screen, the eye muscles tire easily,

leading to myopia. However, the papers do not point out if there are children with autism among them.

A search on Baidu, the biggest search engine in China using the keywords 'Tablet + Autism', 'iPad + Autism' and 'AAC+ Autism' produced several hits. The research showed that in developed countries, iPad is popularly used as an aid in the therapy or daily life of children with autism and it is either helpful to correct their behaviour or promote their communication (King et al, 2014). Some articles, such as 'The Analysis of the Application of AAC in the Communication Behaviour in Children with Autism' (Wei, August 6, 2015) mention the significance of Speech Generating Devices (SGD). A doctoral research paper spoke directly about 'iPads support the therapy of children with autism' (Rongrong, 2013). However, the papers on the use of iPads for therapy did not provide a clear number about how many children are using iPad during their daily life or for therapy in China. Nor could I trace any direct research on how widespread the use of iPad is among Chinese children with autism.

3.4 Summary

The above inconclusive outcome about the extent of use of iPads by children with autism influenced my design decision. Rather than attempting to make a native iOS application, I chose to code in HTML5 and create a responsive web-based app. Given internet connectivity, this would run on a range of devices from smart phones and tablets to laptops and desktops.

4 Methodology

The objectives of this project, as stated earlier in Section 1.4, were:

- To explore, through literature review and environmental scan, the differences in the adoption of technology to support children with autism in Canada and China (please refer Sections 2 and 3);

- To design and develop a prototype mobile app for preschool children with autism in China based on a culturally relevant vocabulary (please refer Section 5); and

- To evaluate and refine the prototype through two workshop sessions with parents and caregivers of preschool Chinese children with autism in Nanjing, China (please refer Section 6).

4.1 Mitacs Globalink Award

I applied to Mitacs for this award and received it in November 2015. This facilitated onsite research in China for four months from December 1, 2015 to March 31, 2016. I decided to develop a prototype and take it to China for evaluation. Accordingly I drew up a project plan and obtained approval from the Research Ethics Board of OCAD University. The gantt chart is shown in Figure 5.

Gantt chart **A Culturally Inclusive AAC App for Autistic Children in China**

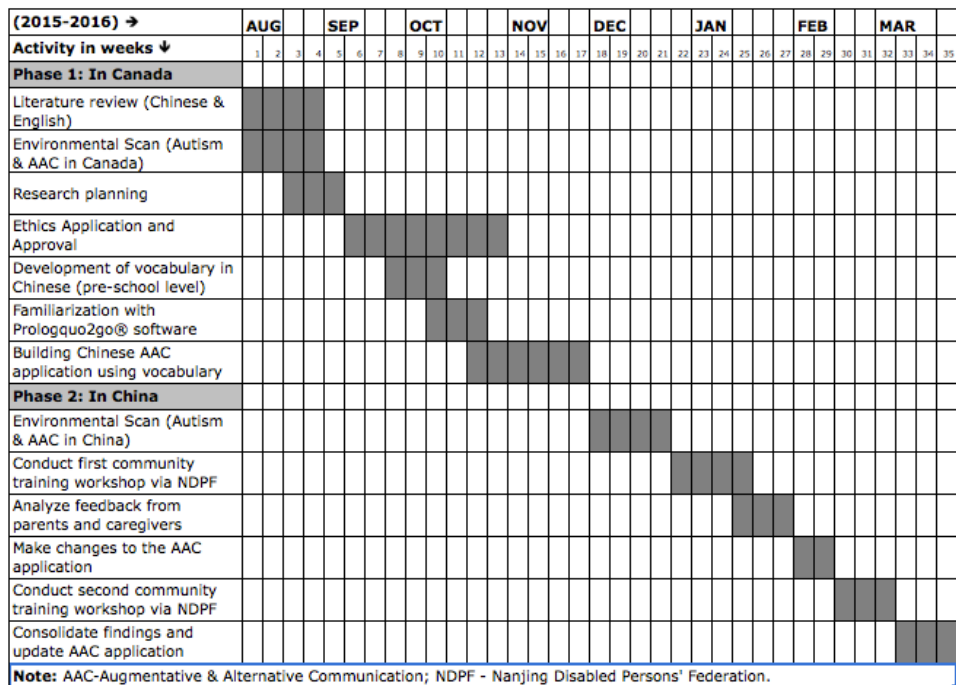| (2015-2016) →	AUG				SEP				OCT					NOV				DEC					JAN					FEB				MAR			
Activity in weeks ↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Phase 1: In Canada																																			
Literature review (Chinese & English)	■	■	■																																
Environmental Scan (Autism & AAC in Canada)	■	■	■																																
Research planning				■																															
Ethics Application and Approval					■	■	■	■																											
Development of vocabulary in Chinese (pre-school level)								■	■																										
Familiarization with Prologquo2go® software										■																									
Building Chinese AAC application using vocabulary														■	■	■																			
Phase 2: In China																																			
Environmental Scan (Autism & AAC in China)																			■	■															
Conduct first community training workshop via NDPF																						■	■	■											
Analyze feedback from parents and caregivers																										■	■								
Make changes to the AAC application																												■	■						
Conduct second community training workshop via NDPF																															■	■			
Consolidate findings and update AAC application																																		■	■
Note: AAC-Augmentative & Alternative Communication; NDPF - Nanjing Disabled Persons' Federation.																																			

Figure 5: Project Gantt Chart

4.2 Project Phases

As can be seen from the project Gantt chart in figure 5, this project was planned in two phases:

- Canada Phase: from August 2015 to November 2015 in Toronto, Canada; and
- China Phase from December 2015 to March 2016 in Nanjing, China.

The Mitacs grant funded the travel and stay expenses in China.

4.2.1 Canada Phase

Research on the use of iPads and AAC apps in both Canada and China (Sections 2 & 3) revealed that there is minimal use of technology for children with autism in China as opposed to Canada (Campigotto, McEwen & Epp, 2013; Kagohara et al, 2013; McEwen, 2014). I approached Gifted People Services[19] (GPS), an organization in Toronto supporting Chinese children with autism, for help with generating the vocabulary.

The GPS offered expert advice towards generation of the prototype app, while XYC facilitated the evaluation of the prototype with parents and caregivers of children with autism.

I conducted research on the general vocabulary for preschool children with autism and how Chinese children appreciate illustrations. With my own experience and understanding of Chinese culture as well as expert inputs from Dianna Jiang the Director of GPS, I developed a vocabulary essential for the daily life of Chinese preschool children in

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[19] http://giftedpeople.ca.

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Canada. Illustrations for the vocabulary terms depicting Chinese culture were produced using graphic design and communication design with Adobe suite software. Proloquo2Go software on an iPad was used to understand the functioning of AAC software. A prototype app for demonstration during the evaluation phase was built with Chinese script (Hanzi), recorded audio (Mandarin) and the illustrations created.

4.2.2 China Phase

I approached Nangjing Xing Yi Cheng Special Children's Rehabilitation Center (XYC)[20] in Nanjing with a request to assist me with research in China. The XYC permitted me to speak with the parents and caregivers. Upon landing in Nanjing, China, I first contacted XYC and confirmed my arrangements with them. I conducted two community workshop sessions with the help of XYC in Nanjing by inviting around 7 to 10 parents and caregivers visiting the centre to each workshop. In both workshops, I demonstrated my prototype AAC app and explained how it would help children with autism in China. I gathered feedback

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[20] http://www.xingyicheng.org/.

from the participants about the app. The workshop sessions were audio/video recorded with the consent of the attendees.

5 Canada Phase: Prototype Building

5.1 Vocabulary Categories

After careful thought, I picked three categories, Family, Food and Toys, for the minimal vocabulary with which a proof-of-concept prototype could be constructed. This is based on my idea that children under 6 have not gone to school yet, and so, eating, playing and family members are the most important things to them.

5.1.1 Family

In China, all the family members have their specific names; unlike western countries where people call all of father's and mother's brothers as uncle, Chinese children are expected to address each family member by their correct relationship name to show their respect. I chose twenty of the most common family members for the Family category of the vocabulary: Father, Mother, Younger brother, Younger sister, Older brother, Older sister, Father's father, Father's mother, Mother's father, Mother' mother, Father's older brother, Father's older brother's wife, Father's sister, Father's sister's husband, Father's younger brother,

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Father's younger brother's wife, Mother's brother, Mother's brother's wife, Mother's sister and Mother's sister's husband.

Being a good illustrator myself, I created each of the illustrations myself using Adobe Illustrator in graphic style to give a simple, clear and meaningful image for display on phones and pads. In the small screens of these devices, too many details or artistic styles could make the images look busy, which might intervene with children's attention in understanding the meaning of the picture. Given in the table below are the illustrations for the above family members.

Figure 6: Illustrations for Family category

5.1.1 Food

For the Food category of the vocabulary, I chose ten items that are very common as food for Chinese children but may not be that common or known in western countries. The idea was that since AAC apps like Proloquo2Go already have pictures of western food, I could include only those unique to Chinese culture to avoid redundancy. The

food items chosen were: Moon cake, Purple mangosteen, Loquat, Hylocereus undatus, Soft shelled turtle, Pomegranate, Bamboo Shoot, Rice dumplings, Sweet potato, Garden asparagus and Catfish.

Figure 7: Illustrations for Food category

5.1.2 PLAY

For the Play category, I chose Lute, Skatekart-red, Chinese chess and Ping Pong. These games are very traditional and special in Chinese culture.
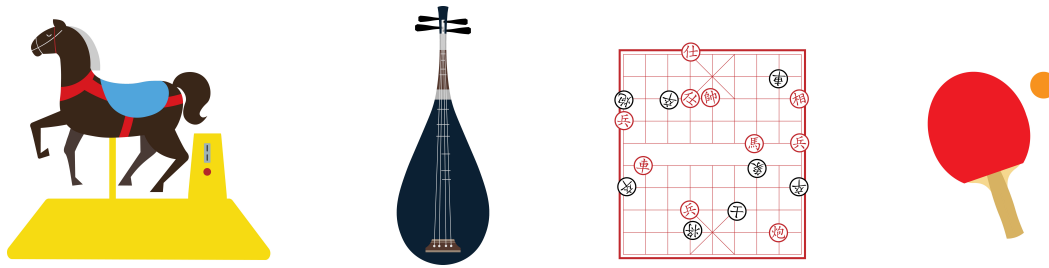
Figure 8: Illustrations for Play category

5.2 Building a Working Prototype

The idea of the prototype was that, when children click the image they want, the app should speak the content of the image. As an illustrator familiar with drawing and painting, I decided to come up with the picture first (as described in the previous section). Then I worked on the logo, sound and action as described in this section.

5.2.1 Logo

My initial logo for the app depicted a child and its mother holding each other's arms firmly and staring at each other deeply.

Figure 9: Old logo

The app is designed for preschool children under 6 years, who may have no idea about how to use an AAC app. So my logo conveyed the idea that a direction from parents is necessary to help them learn how to start, with both the child and the parent using the app together in the beginning and later the child operating it on its own after getting familiar.

Apparently, this initial logo was of the same style of 'shape with vintage colors' like all the images in the prototype. My graphic design teacher in China suggested that I should revise the logo to the style of 'linear in bright and light colors' to separate the logo from the pictures underneath, creating an impression that the logo leads the pictures under it. I revised the logo accordingly. The new logo is shown below.
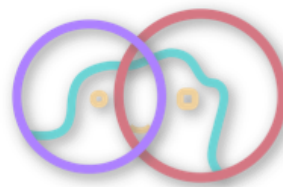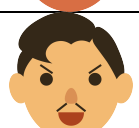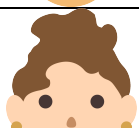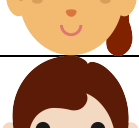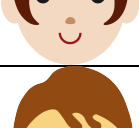
Figure 10: New logo

5.2.2 Images

As described in the previous section on vocabulary development, I created images for each of the items in the three categories: 'Family', 'Food' and 'Play'. The illustrations in each category along with their names in Mandarin and English, are presented in the following three tables, ready for porting into the electronic prototype.
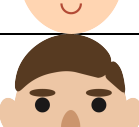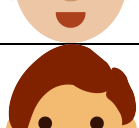
Table 1: Pictures and text for Family category

Picture	Text in Mandarin and pinyin	English translation
	弟弟 dì di	Younger brother
	妹妹 mèi mei	Younger sister
	哥哥 gē ge	Older brother
	姐姐 jiě jie	Older sister
	爸爸 bà ba	Father

	妈妈 mā ma	Mother
	爷爷 yé ye	Father's father
	奶奶 nǎi nɑi	Father's mother
	外公 wài gōng	Mother's father
	外婆 wài pó	Mother' mother
	伯伯 bó bo	Father's older brother
	伯母 bó mǔ	Father's older brother's wife
	叔叔 shū shū	Father's younger brother
	婶婶 shěn shěn	Father's younger brother's wife
	姑妈 gū mā	Father's sister
	姑爹 gū diē	Father's sister's husband

	舅舅 jiù jiù	Mother's brother
	舅妈 jiù mā	Mother's brother's wife
	姨妈 yí mā	Mother's sister
	姨爹 yí diē	Mother's sister's husband

Table 2: Pictures and text for Food category

Picture	Text in Mandarin and pinyin	English translation
	月饼 yuè bǐng	Moon cake
	山竹 shān zhú	Purple mangosteen
	火龙果 huǒ lóng guǒ	Hylocereus undatus
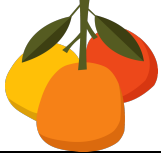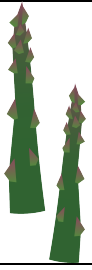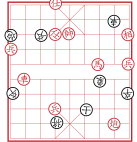
	甲鱼 jiǎ yú	Soft shelled turtle
	竹笋 zhú sǔn	Bamboo Shoot
	粽子 zòng zi	Rice dumplings
	石榴 shí liú	Pomegranate
	枇杷 pí pá	Loquat
	鲶鱼 nián yú	Catfish
	芦笋 lú sǔn	Garden asparagus
	红薯 hóng shǔ	Sweet potato

Table 3: Pictures and text for Play category

Picture	Text in Mandarin and pinyin	English translation
	琵琶 pí pá	Lute
	摇摇车 yáo yáo chē	Skatekart-red
	象棋 xiàng qí	Chinese chess
	乒乓球 pīng pāng qiú	Ping Pong

5.2.3 Sound

After completing the images, I began gathering audio clips online. I looked for audio clips spoke by one person, to have a fixed tone throughout. I wanted the pronunciation to be in standard Chinese language to ensure that children learn the correct way of speaking. The best method I could think of was to download from Google Translate. I thought if I had the idea to download sounds from Google Translate,

other people probably also had that idea, and Google may have thoughtfully provide a way to download their source or people might have created some ways to do that. After some research, I found a website: http://soundoftext.com/ and it allows you to download Google Translate's English pronunciations. Thus I got all the pronunciations of the content of the pictures.

5.2.4 Platform

After thinking over the best platform for posting the prototype, and with a view to being inclusive of diverse participants for my evaluative workshops in China, I decided to host the prototype on a website so that it could be accessed through any phone or tablet. Being from China, I knew that most of the people would have a smart phone if not an iPad or other tablet.

5.2.5 Action

Finding a way to click an image to play the sound was the next step. My original option was to use Axure, because then I could also generate a link for the prototype that I could share with the participants. However, once I tried it out, I learned that Axure has no function to

play a sound by clicking. After some more research, I decided to try out Flash and HTML to select one.

The advantage with Flash was the facility to visually place images on the screen, as against HTML, where screen positions had to be carefully calculated for placing images. However, in Flash the process of making a button to connect image to sound proved to be more complex than in HTML. Each button has four actions and should all be edited to play the sound. This made me decide to use HTML for making the working electronic prototype.

It was easy to find an online tutorial to learn how to play sound by clicking image. But it proved more difficult to fit the images into the screen. Luckily, my friend Yang helped me with these technical issues. I faced another problem in fitting the message board package that I downloaded from the Internet into the HTML code after I had placed all the pictures and audios. Here again, Yang discovered that it was the two CSS file that did not cooperate well. Finally, it was a moment of pride for us to see the app run perfectly on the Internet!

5.2.6 Screenshots

The Star Child mobile app can be used both on a smart phone and a tablet by opening a browser and requesting the url http://58.213.134.155:8888, where the app is hosted.
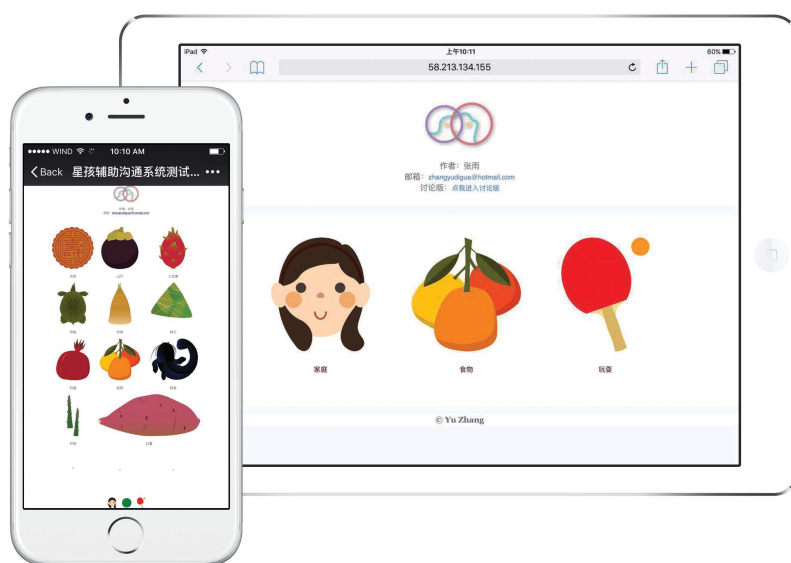
Figure 11: App usable both on smart phones and tablets

Since it is developed using HTML5 as a responsive web app, it can run both on iOS and android phones and tablets. It can also run on laptops and desktops. The only condition is that Internet connectivity is

essential to access the app, which might not be necessary if the app is developed as a native mobile app.

The opening screen of the app is shown below.
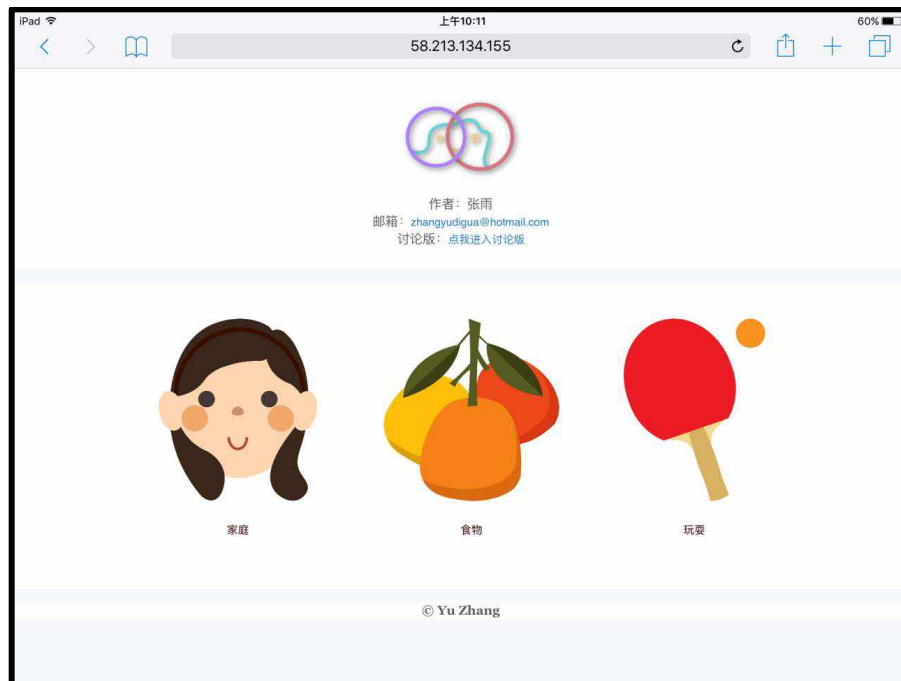
Figure 12: Opening screen of app

Upon activating the icon for the Play category, the screen with images of Play items gets loaded.

Figure 13: Play category screen of app

This is the main screen for action. Clicking on the picture of the lute produces a lute-like sound. The Mandarin word for lute is written

below the picture. Likewise, clicking on the ping pong game produces the sound of a ping pong ball repeatedly hitting the bat and the table. The Mandarin word for the game is written below the picture. Thus, the app provides a multi-modal, actionable, experiential method of learning that could appeal to a child with autism and help in effective learning.

Three icons at the end denote ways to get to the Family screen or Food screen or Home screen. By clicking on the Food icon, the Food screen gets loaded as shown below. When any of the pictures of food items is clicked, a sound associated with the item is heard. For example, clicking on the Purple mangosteen produces the sound of rain, because the fruit grows in rain forests.
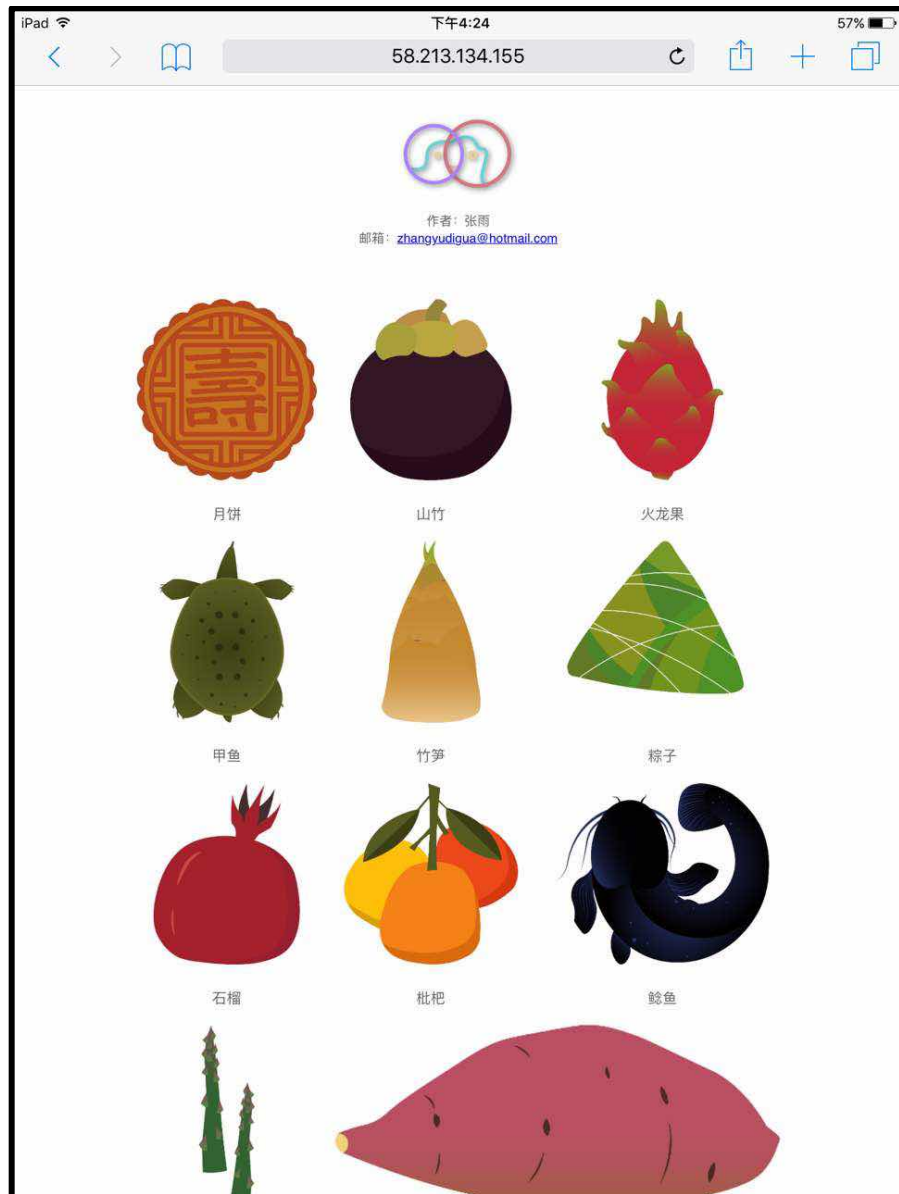
Figure 14: Food category screen screen of app

Clicking on the Family icon loads the Family pictures. On clicking each of the pictures, audio typical of the personality can be heard.

Figure 15: Family category screen of app

The app also has a message board for viewers to leave comments.
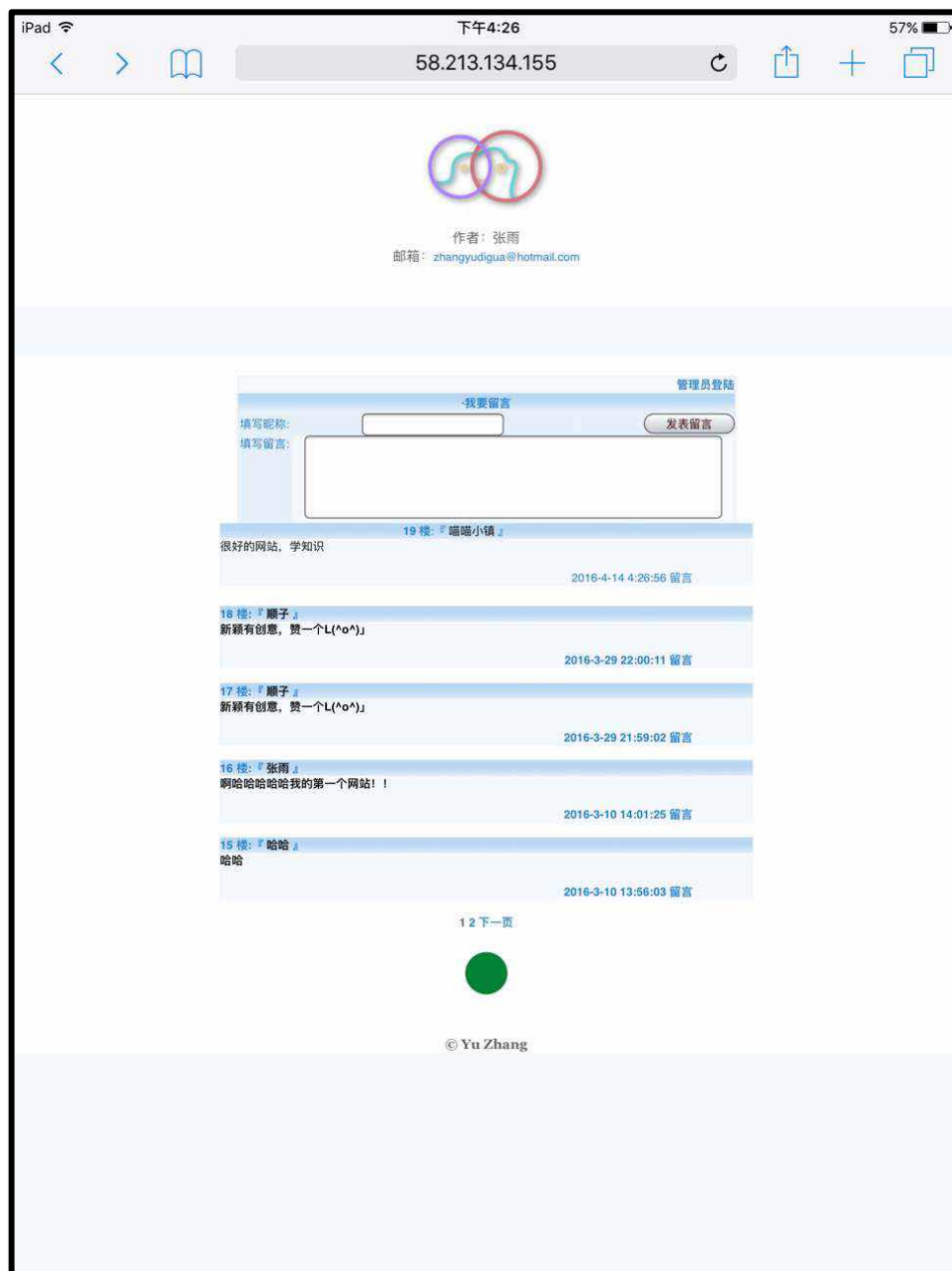
Figure 16: Message board screen of app

5.3 Summary

In this section, the development of a hierarchical vocabulary for a proof-of-concept prototype mobile app for use with Chinese children under the age of 6 years was described, followed by the steps in the building of an electronic prototype. The prototype displayed images that would

6 China Phase: Prototype Evaluation

Having created a working electronic prototype of the app as described in Section 5, I proceeded to Nanjing on December 1, 2015 for four months under a Mitacs Globalink award for conducting an onsite environmental scan as well as evaluating the prototype with parents and caregivers of children with autism in China.

6.1 Workshops

I conducted two workshops in an autism recovery center in Nanjing, China to explore how parents and caregivers receive the Star Child prototype mobile app. Based on feedback from the first workshop, I refined the prototype and used that version in the second workshop to see the how that was received.

The name of the center is Nangjing Xing Yi Cheng Special Children's Rehabilitation Center (XYC) [21]. The center is funded by the Federation of Disabled Persons in Jianye District, Nanjing, Jiangsu and the Bureau of Civil Affairs. It is run by citizens and is not a commercial

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[21] http://www.xingyicheng.org/.

institute. It provides various testing and training facilities to children under 6 years, such as one on one language recovery, relationship development intervention, training on imitation, consciousness, muscle, acknowledgement, expression, etc.

XYC is located in the vicinity of my residence in Nanjing in a busy neighbourhood comprising residences, schools, restaurants and supermarkets. Such a prime location helped me in getting voluntary participants I needed for the workshops. I conducted three sessions, starting at 8.30am, 9.30am and 10.30 am, with a break of 15-min. So, parents and caregivers could attend the session while their children were in class, and could go over to collect them once the session was over. Most of the participants were parents or grandparents, and the remaining were other relatives. Many more people came to visit my workshop than those I am counting as participants, and they just took a look and simply said 'Hmm it's good'.

I had two questions for them:

1. What do you think the app can do for your children?
2. What changes should be made to make that happen?

6.1.1 First Workshop

In this workshop, the volunteers were mostly parents or grandparents, waiting for their children. Most of them had smart phones, but it was hard to say whether they were very familiar with their devices. Some participants did not know where to put the link of the website or did not understand the difference between the address bar and the rectangle of the search engines. Several participants used low function phones that were especially designed for senior citizens. They either shared the phones of other participants or used the devices I provided.

Some of the participants did not have a clear idea about autism or about how to help their children. Basically, their only duty was to bring children to the center, wait till the class was over and accompany them back home. When these participants were asked for ideas for refining the app, they generally said that they were unable to help much.

Setting

The leader of the center permitted me to use a meeting room, equipped with a PC, a printer, a desk, lockers, a conference table and

several chairs. To attract participants, I tool measures to direct people to the room. To pique interest, I hung a poster about the workshop on the glass window of the room so that people passing by could see it. I also put up signage pointing to the room. I placed some fruits, desert and yogurt on the conference table for participants to access easily. I opened my prototype on an iPad and placed it in the most visible place on the table so that when people peeked into room they could see it directly. To sum up, I hoped people would be able to access the room easily and also feel curious about the workshop.

Materials

The following material, prepared under the guidance of the OCADU REB were used in the workshop:

- Information letter, to provide the participants an idea about the process of the workshop, the benefits and the risk;
- A brief description about myself, my school and my previous work on the prototype;
- Consent form for the participants;
- In-workshop feedback questionnaire for them to write their feedback during the workshop;

- Home trial feedback questionnaire for those who consent to work with the prototype with children and record their children's reaction.

A paper with the prototype address written in big font was put in a conspicuous place on the table. Last but not the least, I recorded the date, time and other important information on the workshop session protocol.

I had with me three iPads, one iphone, one Xiaomi smart phone. One iPad and the Xiaomi smart phone were prepared for people whose phones are unable to bring up the website. I used the iPhone to demonstrate to the participants how to use the prototype. The two other iPads were either used to record videos or used by participants.

Research Design

The idea was to create an informal discussion group where people could freely make comments about the app. I encouraged the participants by asking them questions like how they thought the prototype could help children and what else could be added to the prototype to make it useful to children. My assistant was video recording

the proceedings. The recorded conversations, facial expressions and body language of the participants provided useful data. The context of the recordings helped me recall those moments later.

6.1.2 Participant Feedback

Participant 1

He was a grandfather. He and his wife always remained with their grandson in the recovery center for the whole day. They brought their lunch with them. He had a low function phone that was especially designed for senior citizens to use. The phone did not have the capabilities to view a webpage. But he was really curious. He kept watching other volunteer's phones but he did not touch the iPad even when I asked him to try it. He asked me to write down the link and an instruction of where to open the prototype for him. He said he would show it to his daughter-in-law and ask her to try it with the child.

Participant 2

She was a young mother. Her son did not speak too much and learned very slowly. She was passionate and eager to try the prototype.

She was especially worried about the iPad recording video until I assured her that it was only gathering data for research use.

She thought that the differences in the images of different character in the Family category were not significant enough. Even she was unable to tell who is who without looking at the subtitle. Not to mention that the children with autism need more exaggerated and distinctive pictures to attract their attention. She also thought that, although very artistic and beautiful, the pictures were a bit abstract for the children to recognize. For children under 6-years, realistic pictures or photographs might be more recognisable and understandable. Another concern of Participant Two was that, if the main function of the prototype was to click an image and hear the name of the image, that is quite similar to a toy/study machine called Diandu Ji, which had many different brands and featured click images to play audios. And this machine was cheap.

Participant 3

She was a young mother. She asked me what else the prototype could do except click to play the audio of the content name. She also

thought the content of the image did not show its personality and features well. The image and the subtitle were not big enough. She recommended that each page only have one picture to attract children's attention. If there were many small pictures in one page, children may not know where to look at. She also suggested that I could add more categories such as transport. And that food, fruit and vegetables must not be mixed under a single category together. Finally, she concluded that I appeared to not understand children with autism well and that perhaps I could spend some time with children and then design the app based on the experience.

Participant 4

He was a father. He came with his child to the center and left half way through the workshop after he made provided his feedback. He thought the prototype was a bit like Diandu Ji, but the meaning of the images was not as clear as the ones in Diandu Ji. He mentioned that Diandu Ji was easily available in many supermarkets. Another point was that the pictures were too abstract for the little children to recognize.

The participant also felt that the prototype could do better in teaching children art instead of knowledge of the world.

Participant 5

She took a look at other people's phones when they were trying out the prototype. But she refused to give any comment or sign a form. She simply repeated that 'I am not going to write the feedback.'

Participant 6

She was a young mother as well. She was interested in the prototype but she had no idea where to put the link on her phone.

Participant 7

She was a young mother. She argued that the pictures I made had already been done. She recommended that maybe I could draw some pictures that no one had drawn before. She also thought that I could make one object become a series. For example, if I draw an oil pastel, I could draw a series of different oil pastels. This could be a way for children's further understanding of the content. They could learn that even for one thing, it could have different forms. The participant also

thought that, being told the name of a picture did not let children learn too much, and prolonged viewing of the iPad hurts children's eyes. She also thought that the meaning of the pictures is not clear enough. The participant mentioned that it was a good choice to use electronic equipment to teach children with autism. Because electronic devices are dynamic with different elements like windows, colours, etc., children are easily attracted to them. She also said that children with autism learn things slowly. Things that are easy for other children could be difficult for them. She also recommended that I should add more categories such as: the concept of time, emotions, colours, shapes, the concept of big and small, tall and short, and the different occasions and their functions. She also mentioned that an exaggerated and vivid picture was more appealing to children with autism. She also thought that my pictures were too abstract, use photographs may have better result in teaching children the knowledge. However, there had already been enough photographs for children with autism to use, so in teaching children with autism, I could come up with other methods. For example animation suits children with autism better for teaching than static pictures. Animations that are exaggerated and meaningful are more attractive due

to their movement. When it came to the Family category, the participant thought that it was hard to tell which family member is which one. She said maybe I could create an animation for each of the members, and the audio could be a sentence that can show the personality of that family member. For example, for grandma, upon clicking the image, the grandma could smile at the children and say, "Is your bag heavy? Let me carry it for you". She also recommended adding ask and answer functions on the prototype, and letting the children know if they answered the question correctly or provide with them the correct answer. The participant also told me that children with autism were very rigid. For example, only perfect circles were circles. Imperfect circles were other things.

Participant 8

She was a middle-aged woman. She said she would like to use the prototype in future. But was not sure how to put the address of the prototype in the address bar, and she also did not know how to bookmark the link and add it to the menu of the phone. She ask me to help her and she also recommended my prototype to those seated

around her. She recommended me to add more groups of pictures: clothes, parts of body, shapes, colour, animals, fruits, vegetables, dessert, food, living goods and electrical appliances. She thought all of this could help to promote children's understanding. Comparatively, she believed that I had already got enough items for the category of Family.

Participant 9

She was a young mother. She worked in HuWei Technologies Company, a famous information and communication company in China, as a programmer. She said she could understand that making this prototype might not be easy for a student whose background is art. She talked with me for a long time. She thought that the personality of each family member was not clear enough. It was possible to tell between female and male, but it was really hard to recognize people in the same gender in similar ages, for example, aunts. She thought I did a good job with the shapes of fruits, but for the Family category, some images were too ambiguous. She also recommended that I could choose some items like sporting equipment or transport if I would like to show my illustration skills, because they all have unique shapes and are easy to

recognise. She also told me that children read from top to bottom and they were able to remember the location of the picture. She also thought children with autism was still a very large and diverse group. So, I should only target a small market segment when designing teaching materials. She told me that to do something for children with autism was a good idea. In China, there were many problems for the children with autism that need resolution. She also said that it was hard for grandparents to recognize that their children act different from other children while young parents would be sensitive to their children's situation and take action immediately. She said she hoped that children could adapt to the society and complete their goals. Children could maximise their strong point during their growth. For instance, if some children can only focus on one thing at one time, then it would be good to just let them focus on that one thing and do it better.

Participant 10

This participant thought that there were already too many picture cards for teaching children with autism and that my work was kind of redundant.

Participant 11

She thought the prototype as it stands, could help children know the names of the images, but not their meaning. The prototype ought to also facilitate self-study by the children. Whenever children would like to listen, they should be able to click and hear the audio. She told me about a situation relating to children with autism using her grandson as an example, . She said her grandson said 'mom' just once and did not say anything more after that. The child played with computer, smart phone and electronic toys every day and could not focus on lessons like the other children. And she thought that children with autism like things that are dynamic, colourful and keeping changing.

6.1.3 Summary Feedback – Workshop One

Overall, per the consensus view, all the participants thought that the prototype taught children basic knowledge rather than facilitate communication. And there were several other suggestions that were repeated by different participants. First, the images in the prototype were too abstract for children's recognition. Second, the family members in the Family category did not have strong enough personality to be

distinguished from each other. This is problematic and perhaps insoluble since there are so many confusing relationships. Third, the features of the images could be made stronger. Fourth, the audio says the name of the image, but this does not help with understanding it. Fifth, trying to come up with unique pictures that had not so far been created by others would be more valuable. Perhaps consider animation.

In addition, there were several other observations by my participants, and ideas generated from those observations, that I feel are worth noting. Unlike the summary above, there may not necessarily have been a consensus or near consensus; however, I felt that these were important to take account of:

- Creating affordances for technical problems
- Perhaps an app/website could be created that would be compatible with the special Senior's phones
- My research results were constrained by participant's legitimate fear of the Chinese Government being privy to my data. This directly impacted more than one participant and was probably a factor in the case of a few others.

- A number of participants mentioned a device called Diandu Ji and suggested that my app duplicated said. Therefore, I must make certain that this is not the case.

- More categories of information: transport, clothing, body parts, shapes, colour, animals, fruits, vegetables, dessert, food, living goods, electrical appliances, sporting equipment

- Worth repeating "I appeared to not understand children with autism well and that perhaps I could spend some time with children and then design the app based on the experience."

- Target a particular segment of the market for autism gadgets

- Adding ask and answer functions so users will know if their answers are correct as well as provide with them the correct answer.

- The insight that children with autism are very rigid. For example, only perfect circles were circles. Imperfect circles were other things.

6.2 Prototype Refinement After First Workshop

Following one piece of feedback received from participants of the first workshop, I carried out the following refinements in the prototype:

1. Changed the audio for all the images from words to descriptions;
2. Simplified the logo;
3. Removed the black frame around the pictures; and
4. Moved the message board to a separate page.

To create descriptive audios for the images in the 'Family' category, I sent out a message via Wechat inviting my family and friends to send me a voice message around 5 seconds, pretending that they were talking to their children, niece or nephew. Then I uploaded these voice files to my computer and coded them into the HTML file to replace the old audio. Since iTunes cannot access the voice messages from Wechat, I downloaded a piece of software called Synchronization helper (同步助手) to transfer the audio from Wechat on my iphone to my computer.

6.2.1 Second Workshop

Setting

Based on my experience at the first workshop, I set up the second workshop differently. I did not use a room for the second workshop because during the last workshop, I had sensed that people were not that used to, or comfortable with, a discussion group. The atmosphere was a bit serious which led to a reluctance to participate. For the second workshop, therefore, I arranged for desserts for the participants to eat. Then I approached each individual to ask whether they would like to try my prototype and give me feedback.

Materials

The materials I used were: an iPad to display the prototype, an iPhone to record the voice, and a paper bag full of dessert to thank the participants.

6.2.2 Participant Feedback

I asked the parents and caregivers that were resting outside the classrooms what they thought about my prototype. I told them that the

prototype was for improving the cognition of children with autism and asked them if they thought that it would help, and how it could be improved.

Participant A (was Participant 7 in the first workshop)

When she glanced at the green button at the bottom, she did not recognize it as the home page button. For the Play category, she liked the sound of chess, she thought it displayed the essence of Chinese chess and the sound itself was attractive. She also liked the sound of the lute. She thought it enabled children to know the real sound of the lute. She also recommended that I could create several more items for instrument and just add their original sound to them. She also recommended me to use the original sound of the item, the sound created by the object, instead of the sound that only related to the object. When it came to the Family category, she said the prototype has too many family members, and children with autism will not be able to remember that many. I could simplify this group by reducing parents' brother and sister's family, there were too similar and not highly used by children. The sound uttered by human to demonstrate emotions could also be used for the

pictures of emotion if I made them. She said I could also add the category Occasion, using animation, because photographs may contain unnecessary information and may divert the attention of children. In the end, she recommended that I should make a website that provided pictures for different categories. Because, parents and healthcare providers usually print pictures to train children, and finding appropriate pictures online is time consuming. She also mentioned that the device's screen might hurt children's eyes. She told me that I could search on online shopping center like TaoBao, and get an idea of what kind of picture cards for children were sold online and how much they costed.

Participant B

She was a senior citizen. She accepted the dessert but refused to look at the prototype or listen to me when I tried to explain my work to her. She just kept saying I don't know.

Participant C

She was a senior citizen. The font of the subtitle was a bit small for her because she looked tired when she was trying to figure out what

was written below the pictures. She had a low function phone and could not open the webpage, so I displayed my prototype on the iPad. She was very kind. After she heard that the project was my MRP, she got interested in providing feedback. She thought the prototype was good due to its bright colours, distinct shapes, and the amazing sounds. She believed that children with autism would be curious about it. The prototype will definitely bring children joy and curiosity, leading to activity. She said this prototype could also be used to teach children about colors. She also recommended that I add the category of Profession such as policemen, firefighters, etc. She told that, the teaching materials for the children with autism should be updated periodically to sustain their curiosity; else children could get bored and not want to learn. She told me that teaching materials on electronic devices, such as my prototype, were more suitable for young parents to use with children, and senior citizens were not used to those technologies.

Participant D

The participant suggested that the audio should play many times over for children to memorise and practice.

Participant E

The participant recommended that, the audio in the category of family could be redone with the person speaking slower. The current speed of some of them might be too fast for children with autism to follow.

Participant F

He was a grandfather. He finished watching me display the prototype. But when I asked him for feedback, he said he really had no idea. He told me that if I could wait his daughter would be coming to the center in the afternoon and I could ask her for a feedback.

Participant G

She was one of the teachers in the center. She thought that for the Family category, there should be children's own family member's photographs so that they could learn who they were actually. Using an illustration for 'father' could result in confusion. Children may think that 'father' was that picture.

Participant H

She was another teacher in the center. She believed that characters might limit the imagination of children under age of 6. She also thought that the distinction in the personality between different family members was not strong enough. Children did not know character yet, and might not recognise the picture. The audio of the picture was part of the knowledge. So, it should also be designed to help children learn the content. For example, the audio for the Purple mangosteen could be a description like ' The Purple mangosteen is sweet, with black and hard cover. It grows in wet areas such as rain forest.' Audio like this could facilitate the understanding of the content of the image. My original audio for the mangosteen was the sound of rain, aiming to focus on the environment where it grew. The participant said, this might lead children to think that they were going to the rainforest to pluck mangosteen. She also recommended that, if I really want to use the audio function of the webpage, I could create more items about musical instruments, because the sound effect is educative there.

Participant I

She was teaching in the center as well. She said they mostly used paper printouts of pictures for teaching children in the center. Children younger than six years might not be able to use phones or iPads. More importantly, children with autism needed the kinaesthetic experience of touching and feeling the materials. Some of the children might even destroy the devices. But still, she said that my choice to use an electronic device as the platform was great because colour and audio were generally good to attract children, and would certainly be appealing to children with autism.

Participant J

She was a young teacher as well. She thought the pictures were too difficult for children and I may need to narrow down the scope of the target user.

Participant K

She was a teacher in a high school. She thought the audio for the Play category was good because each audio was the sound created by the

instrument itself. The homepage button did not convey the information that it was a home page button. She also recommended that I could create more items about musical instruments to enhance the use of audio. And she thought that the features to learn about fruits were the taste and the smell, so a webpage was not good to display them. She thought I could especially use the prototype to teach children sounds.

6.2.3 Summary Feedback – workshop Two

With respect to the areas of the prototype that were not modified, many comments made by participants of Workshop One resurfaced in Workshop Two. (See 6.1.3.)

But, as we can see from comments, from participants A through K above,, after enhancing the audio of my prototype, the participants at the second workshop suggested including even more audio in the prototype. Most of the participants thought that elements of the pictures should be designed to help children with cognition. Also some of them made a good point that I could use the features of the electronic devices, such as sound and animation, which are their unique functions that traditional teaching materials do not have. Another good thing would be

to consider what is essential in the education of children with autism in China first due to the cultural differences and develop an app exclusively for them. To adapt an AAC app from a western country to a Chinese version may not help very much. The scope I had taken on for target users, namely children under 6 years with little or no speech, was also not sufficiently specific enough since those children might vary in intelligence. The prototype could be clearer about the app's intended market/user group.

7 Reflective Overview

I came to this project with no practical experience or knowledge of autism. As I am interested in illustration and graphic design, my initial idea was to create culturally relevant illustrations to expand the use of the Picture Exchange Communication System (PECS) to include illustrations useful for Chinese children with autism. While using the Proloquo2go AAC app, I got interested in designing an equivalent AAC app for Chinese children on iPad.

As I had no idea about children with autism, I visited a centre for children with autism in Toronto called the Gifted People Services[22], where the patrons are primarily Chinese. I watched a Chinese-born Canadian child with autism communicate with her mother using the iPad with the AAC app Proloquo2Go. She was familiar with the device and the app. Further, the app was highly customised to help in many areas of the child's life. However, using the iPad did not appear to be her preferred choice. She preferred to scream out to express what she wanted. Her mother, to train her, asked her to tap her needs on the iPad.

[22] http://giftedpeople.ca/

The child pressed the animation icon. Her mother tried telling her that it is better do some other activities. The child kept pressing the icon of animation and then began to scream again. Her mother tried to persuade her child, in vain, to use the iPad. From this experience, I gathered that while it might be possible to teach children with autism to use an iPad to communicate and also require them to do so, children may or may not always be comfortable using it. The experience left me deeply changed and full of doubts about being able to create an AAC app for them.

I had a meeting with the Founder and Executive Director of the centre, whose daughter has Global Developmental Delay and Autism Spectrum Disorder. She has studied autism in the hope of healing her daughter. Through running the centre, she has accumulated knowledge and experience about the life of children with autism. During our meeting, she gave me plenty of information. However, given that she is not a researcher, she could only go as far as an observer of children, and was not equipped to understand children's behaviour. She expressed the opinion that iPad can prove expensive for Chinese families.

Meanwhile, my application for a Mitacs Globalink award got approved. This allowed me to spend four months in Nanjing, China and interact in person with parents and caregivers of children with autism in recovery centres in China. This rekindled my interest in creating an AAC app. But, the research I did in the meantime showed that designing an app that runs on an iPad might not be useful because I could not get enough evidence confirming use of technology in China with children with autism. This shaped my design thinking to create a web-based app that could also be run through a mobile device. I designed and built the prototype and landed in Nanjing with three iPads, an iPhone and a lot of anxiety to get my prototype evaluated.

The first two months, I volunteered in two autism centres in Nanjing. I recognized the vastness of the diversity and uniqueness of children with autism. I also found that paper-based tools are still the main support systems rather than technology in those centres. I received critical feedback on my prototype from parents and caregivers. Even implementing one of their suggestions made the app much more welcome to them. I am looking forward to refining the prototype based

on all that feedback and releasing an app, which could be the second AAC app in Mandarin after Little Rain Drop. The autism centre that I visited in Toronto has expressed interest in using the app with the children in their centre. More importantly, I have plans to create plenty of illustrations for use as paper-based PECS in autism centres in China.

I would say that the effectiveness of teaching material for children with autism depends both on the intelligence of researchers and designers and the love of parents and caregivers. After designers create the app, it is the parents and caregivers who decide how to use it to help the children. There is extreme diversity among children with autism; they vary a lot from one another. Therefore, even with the same app, ways of using it to teach each child might not be the same. This project has left me with a sense of purpose, and that is what I like best about the experience.

8 Conclusion

8.1 Contributions

8.1.1 Prototype AAC App

The primary contribution of this project is the Start Child AAC app for helping Chinese children with autism to communicate. With bright, colourful images of things relevant to the Chinese culture, and audio narration as well as text provided in Mandarin, the app is designed to be appealing to Chinese children.

8.1.2 Implications for Inclusive Design

The hallmark of inclusive design is to: (i) identify an underserved target group marked by diversity and uniqueness; (ii) design inclusive processes and/or tools for them; and (iii) aim for a broader impact reaching beyond the target group [23]. These three dimensions of inclusive design unfolded in my project as described below.

> i. I selected preschool children with autism in China in a Mandarin-speaking community of Chinese culture as the

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[23] http://idrc.ocadu.ca/component/content/article/48-library-of-papers/443-whatisinclusivedesign.

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target user group. The context in which they were underserved was in receiving technological support for development of communication.

ii. I designed and developed a prototype proof-of-concept mobile AAC app for the above group by extending the design of some AAC apps available in English..

iii. The AAC app produced can serve not just children with autism but also novice learners of Mandarin language as a learning tool, or for foreign travellers in China as a ready communication tool; as well, the pictures created for the app could be used to promote Picture Exchange Communication in children with autism in China, which I did not find to be very popular in the two recovery centres that I visited in Nanjing.

8.2 Future Work

The current version of the Star Child AAC app is a prototype proof of concept. The prototype will be refined based on the feedback received from parents and caregivers at the Nangjing Xing Yi Cheng Special Children's Rehabilitation Center in Nanjing, China. The Gifted People Services autism centre in Toronto with primarily Chinese patrons is eager to use the app with children in their centre when it is ready.

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