ISBN: 978-981-14-2064-1

Requesting Help Module Interface Design on Speech-Generating Device and Augmented Reality for Children with Autism Spectrum Disorder

Chuan-Po Wang [1,a] Cheng-Hui Tsai [2,b],

Department of Industrial Design,
[1] Chaoyang University of Technology, Taiwan (R.O.C.)
TEL: +886-926-776317
Center for General Education,
[2] National Taichung University of Science and Technology, Taiwan (R.O.C.)
TEL: +886-935-351201
[a]chuanpowang@gmail.com, [b]chenghuitsai@nutc.edu.tw

Abstract

This research focused on three child participants with autism spectrum disorder (ASD). The goal was to strengthen the effectiveness of their Requesting Help and expression capabilities, use Requesting Help modules, remove static key images, and use Augmented Reality (AR) in combination with the dynamic video clips in the Key Partial Video with Action (KPV). This study provided development of request-assistance training and expression in conjunction with the Auto Organizational Menu (AOM), multiple case studies and withdrawal designs, training-response methods, and comparison of outcomes.

Keywords: Autism Spectrum Disorder, Key Partial Video with Action, Augmented Reality, Auto Organizational Menu, Multiple Case Studies, Withdrawal Designs.

Introduction

Autism-related language disorder with moderate or severe disabilities, including lack of sentence-organization ability, makes it difficult for those with ASD to communicate with others [1, 2]. ASD children have marked difficulty with vocabulary, lack of or shortcomings with oral organizational capacity and cannot properly communicate with others effectively. In particular, people with moderate or severe disabilities cannot systematically narrate an incident and cannot follow pragmatic rules provided by others. Proper conversation leads to cognitive problems. When ASD children are faced with difficult circumstances, they have no ability to seek help from others, etc., which in turn can result in their inability to communicate effectively [3].

Few studies have explored the effectiveness of the interface designs (such as hierarchical menus, pull-down menus, message formulation and retrieval mechanisms, and content presentation methods) of PE, PECS, VOCA, and SGD in AAC systems [4, 5, 6]. Those with moderate ASD suffer from communication problems and can communicate using existing AAC communication graphics systems such as Boardmaker, Proloquo2Go, Picture master language software, and iCAN design communication pages. However, operationally, if there is insufficient sentence ability, the AAC communication graphics system will be difficult to use during most of the operation process, especially in the selection process. Individuals with autism cannot follow pragmatics, grammar rules, and even arbitrary selection of the map, owing to their auxiliary cognitive difficulties. The user may select a picture of the family in order to express something such as “I want to go home,” “I wonder whether my family will take me home,” or “I want to find my family,” etc. Hence, the research into organizational design content is particularly important and a Requesting Help module interface design will be created.

Augmented reality (AR) is an interactive experience of a real-world environment where the objects that reside in the real-world are "augmented" by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory, and olfactory. It alters one's ongoing perception of a real-world environment. Augmented reality e-books are an interesting reading experience in the application of cultural education learning. Billinghurst, Kato & Poupyrev [7] designed the augmented reality Magic Book to integrate the animation content into the books and superimpose them on the books. In the unit, the reader still maintains the general flipping movement while reading, but he can see the virtual model animation while watching, allowing him to experience the stimulation of virtual information in the real reading experience and also providing him with a more novel and interesting experience. Liarokapis and White [8] have also tried to use augmented reality in building a digital virtual environment for museums. Through marker identification, three-dimensional architecture corresponding to a real environment is presented in a virtual digital environment, through three-dimensional space (three-dimensional); the appearance of space can enhance the user’s identification of objects in real space. In addition, many places are remote and may be difficult or impossible to reach in person; this is true of areas inhabited by the aboriginal tribes. The Internet cannot provide the feeling of being in the actual realm. Virtual reality can teach time-space in relation to the scene, even through time and space. The individual can feel the scene’s conditions, but the augmented reality can be further interacted with or experienced after it is set. Shelton & Hedley [9] found that using augmented reality in teaching experiments can assist teachers in instructional activities using simpler teaching materials. Augmented reality can increase student perception and enhance understanding. However, static or fragmented images is too limited and ecologically ineffective. Dynamic video is advantageous, but children with ASD have special preferences that don't focus on dynamic video content. Therefore, children with ASD cannot always be attracted to the media. Therefore, we used augmented reality (AR) interface to

attract their attention. In addition, to decrease their visual stress and loading, we chose suitable content that was less than 1 minute long, focused on specific social action, and combined the AR interface with a video-modeling (VM) strategy. Other researchers have already provided evidence that AR is useful for training normally developing children [10].

Methodology

2.1 The design process of the communication menu

The communication menu was developed in three stages:

(1) In the first stage, during which we conducted preliminary interviews with more than ten autistic children's parents and teachers, we designed the questionnaire to investigate the parents and teachers by requesting help from participants with "core vocabulary" graphics and related words. We collected a total of 140 words, then made more than 10 communication boards. As members of the Speech-Language-Hearing Association of Taiwan, Li Shu-E and twelve language therapists meet regularly to discuss the vocabulary graphics and have compiled a vocabulary of more than a thousand commonly used communication terms to make a communication graphics system. The design team collected the details of how children with ASD learn communication skills by pointing at paper-based picture cards. They used the concept of core vocabulary to design an interface so that participants can learn by repeatedly practicing specific sentence patterns [11].

(2) In the second stage, researchers tried to design textbooks based on "core vocabulary" and refer to the ISO copyright-free graphics library to redesign and select the most frequently used words with graphics to make sentences. For example, table 2-1 lists subject, verb, object, adverb, or subject, verb, adjective, adverb, etc. The Requesting Help module served as the main communicative content as a core vocabulary for the communication layout production; because of different needs, it was organized into ten categories. There are dozens of vocabularies and they are used as marginal vocabularies.

Researchers used different colors to classify the different parts of speech (for example yellow for subject words, orange for affirmative and negative words, green for verbs, etc.) to facilitate a visual search for symbol positions, and they adopted the concept of a structured layout design to guide participants in using lexical phrases in sequence.

(3) In the third stage, due to the difficulty in understanding the complicated operation of some cases using the interface, we hoped to further study the differences in the understanding of meaning. With this stage of intervention, we hoped to further improve the participants' ability to conduct further operational communication and request help. Therefore, the information was collected for use in formulating eight modules of Requesting Help recognition concepts for an initial working prototype vocabulary. The operational communication content of requesting help was then developed. Scenarios were created (Appendix 1). We then gave our prototype to parents or caregivers to judge its value and verify its usability for children with ASD.

(4) In the fourth stage, the interface refinement and assessment stage, our system was installed onto a tablet device for the four children, the end-users, to test. The designers, special education instructors, and speech therapists assessed the effectiveness of the refined interface. The interface showed a table of the parts of speech: question words, subjects, verbs, objects, and nouns. The users could select an image based on the parts of speech in the table. Because the child has difficulty making a sentence, and with the choice of image-exchange expressions, many past studies have adopted effective methods such as the Picture Exchange Communication System (PECS), picture exchange (PE), and speech-generating devices (SGDs). We tried to employ this method using S, V, objects, and N to use the image word class to overcome the difficulties of autistic organization, word expression, organization and pronunciation. When each figure in the grid of the user's potential sentence was filled in, a grammatically determined location of S, V, objects, and N in the sentence was automatically organized, formed, and uttered by the SGD connected to our menu.

Table 2-1. Use to Make Sentences and Rules

Style No.	**Sentence and Rule**					
1	S	V	N			
2	S	V	Adj			
3	S	V	Adv	Adj		
4	S	V	Adj	N		
5	S	Conj	O	V	Adv	Adj
6	S	Conj	O	V	Adj	N

N= noun; Adv= adverb; V= verb; Adj= adjective; Conj= conjunction

2.2 Using AOM with AR to promote the Requesting Help effect

Because most people with ASD are already cognitively impaired and unable to fully understand others, their capacities for social interaction and verbal expression are directly affected, which leads to communication disorders. The third stage of this study included (1) using AR and captured KPV with key scenes, and then using these videos to stimulate people with ASD to correctly identify the request for help expressed in two different images, including static key images with real people and a short video; (2) evaluating the outcomes of the Auto Organizational Menu (AOM) intervention for improving operational identification and facilitating the progress of coherent expression.

2.3 Method of using AOM with AR to evaluate communication effectiveness

2.3.1 Participants

The participants of this study (all given pseudonyms to guarantee anonymity) were 3 children with ASD (2 boys and 1 girl). All members of the ASD group had previously been diagnosed with ASD by clinicians using the multidisciplinary

assessment of clinical services in Taiwan; the Wechsler Intelligence Scale for Children (WISC) was used to determine physical and sensory inabilities that might affect their speech and language development.

ASD participants (mean age = 7 years old; age range: 6–8 years; intelligence quotient [IQ] scores: [a] full scale IQ [FIQ] = 71.33 ± 3.06; [b] verbal IQ [VIQ] = 73.33 ± 4.16; and [c] performance IQ [PIQ] = 67.33 ± 2.89). Moreover, their sensory abilities were within the abnormal range; e.g., the mean FIQ was lower than 80. All participants had a disability identification card issued by a medical institution in Taiwan and had been counseled in special education schools and institutes in Taiwan. All participants signed a youth consent form, and parental consent forms were obtained before the participants were enrolled in the study.

2.3.2 Settings

All instructional and probe sessions and other procedures occurred in teacher-selected computer classrooms in Kaohsiung elementary schools. Participants sat at the table and the trainer sat across from them. To begin the intervention test, an experimenter showed the Requesting Help question paper to the children and asked them to look at the pictures of each scene. These ten scenes are generally recognized universally and are created by people all over the world. These scene types are chosen based on caregivers' and teachers' preferences. The participants answered each test question (Appendix 1) after looking at the pictures, and then selected an appropriate answer for the KPV Requesting Help expressions (see Figure 2-1). An independent observer was present during all sessions to collect interobserver agreement data.

2.3.2.1 HP Reveal

We used HP Reveal as our platform because it offers the widest set of features and capabilities, which gives developers the freedom to extend their visions without technical limitations. With support for iOS, Android, and Unity 3D, the HP Reveal platform allows users to create an interactive interface that can reach the most users across the widest range of platforms. (see Figure 2-1).

Figure 2-1. HP REVEL Website

We selected ten scene videos from the caregivers and teachers that contained Requesting Help communication, illustrated the appropriate physical distance with low levels of metaphor, represented distinctive themes, and illustrated the appropriate physical distance in Taiwanese culture. The scenes included significant nonverbal communication (body movements and clear facial expressions) that vividly expressed the request for help. In addition, there were interactions and dialogue among the characters in each story. Excessively complicated and abstract videos were excluded. All scenes depicted a variety of requests for help and were displayed at the same resolution of 1024 × 768 ppi on a 20-inch monitor. Each scene was approximately 10 seconds long (see Figure 2-2).

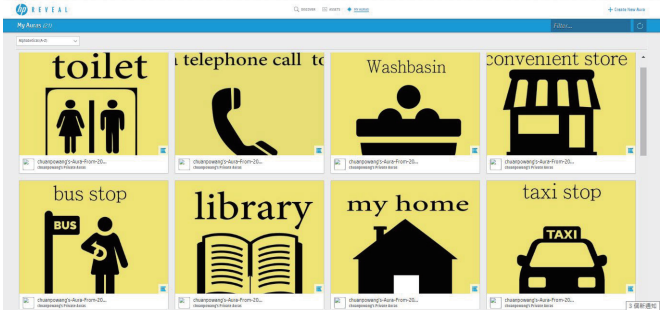

Figure 2-2. Ten scene videos and trigger definitions

2.3.2.2 Key Partial Video with Action (KPV)

Key Partial Video with Action (KPV) was created from frozen images captured from requests for help. In each video, we selected 10 to 20 video-frames sequentially in accordance with video context and story development, including action for assistance, situations, and body movements to develop KPV materials for participants with ASD. KPV scenes were created from images captured from caregivers and teachers. The goal was to capture critical scenes and to use key action scenes to repeat the film, so that the participants by repeated true images would be matched with Requesting Help identification to achieve cognitive social scenes (see Figure 2-3).

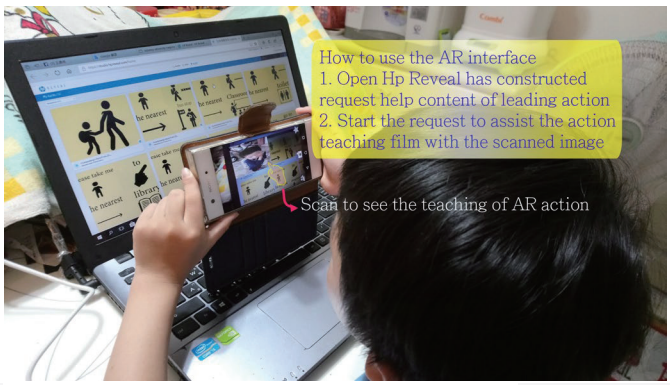

Figure 2-3. Example of KPV materials created from AR

Results

Results of KPV with AR, AOM Intervention and evaluation

4.1.1 Judgments of perceptions of others

TD children in both KPV with AR with the AOM Test was 88% and 98% when using the ABCB. On the other hand, the

correct judgment rate of the children's perceptions of others improved from baseline 1 at 83.78% when using the AOM to 98.43% at Intervention 2 when using the KPV with AR.

4.1.2 Situational comprehension

The situational understanding rate of the 3 participants with ASD also increased from Baseline 34% to Reversal 55%. In the AOM intervention, determining the correct expression of KPV expression also significantly increased from 69% to 72%.

We used paired t-tests to compare the Baseline test values with the Intervention 1, Reversal, Intervention 2, and Maintenance test values. The latter were all significantly ($p < .05$) higher than the Baseline values.

DISCUSSION AND CONCLUSIONS

The KPV with AR intervention helped the children improve their ability to judge and to determine the relationships between roles and activities, and the AOM helped them manipulate the answers relating to the sentence and communicate with the therapist. This shows that a limited amount of information with structured and specific close-up images helped the children improve their situational awareness and perceptions of others. Although children with ASD might encounter passive barriers, the visual support and structured situational characteristics of the scenes were beneficial to their perceptual awareness, and also helped them to develop their social interaction function.

References

[1] F. Kurtcu, An analyze of high school web interface designs in terms of graphic design Procedia - *Social and Behavioral Sciences* 46, 2012, pp.5661 – 5665.

[2] C. Binger and J. Light, The morphology and syntax of individuals who use AAC: Research review and implications for effective practice. *Augmentative and Alternative Communication*, 24(2), 2008, pp.123–138.

[3] D. Beukelman & P. Mirenda, Augmentative and alternative communication: Supporting children and adults with complex communication needs (4th ed.). Baltimore, MD: Paul Brookes, 2013.

[4] M. C. Boesch, O. Wendt, A. Subramanian, & N. Hsu, Comparative efficacy of the Picture Exchange Communication System (PECS) versus a speech-generating device: effects on social-communicative skills and speech development. *Augmentative and Alternative Communication*, 29(3), 2013, pp. 197-209.

[5] L. A. J. Van der Meer, et al., Communication interventions involving speech-generating devices for children with autism: A review of the literature. *Developmental Neurorehabilitation.* 13(4), 2010, pp.294–306.

[6] J. Sigafoos, et al., A Comparison of Picture Exchange and Speech-Generating Devices : Acquisition, Preference, and Effects on Social Interaction. *Augmentative and Alternative Communication*, 25(2), 2009, pp.99–109.

[7] M. Billinghurst, et al., The Magic Book: A Transitional AR Interface, Computers & Graphics, 25(5), 2001, pp.745-753.

[8] F. Liarokapis, and M. White, Augmented Reality Techniques for Museum Environments. The Mediterranean Journal of Computers and Networks, 1(2), 2005, pp.90-96.

[9] B. E. Shelton, and N. R. Hedley, Using Augmented Reality for Teaching Earth-Sun Relationships to Undergraduate Geography Students. Paper presented at the First IEEE International Augmented Reality Toolkit Workshop, Darmstadt, Germany, 2002.

[10] C. H. Chen, et al., Design an augmented reality teaching system with concept mapping technique. In: Proceedings of the Annual Conference of JSSD the 53rd Annual Conference of JSSD. Japanese Society for the Science of Design, 2006. p. 125-125.

[11] G. Vanderheiden, and D. Kelso, Comparative analysis of fixed-vocabulary communication acceleration techniques. *Augmentative and Alternative Communication*, 3(4), 1987, pp.196-206.

Appendix 1

Title Design/Session	The correct rate \ Time					
	1	2	1	2	1	2
Participant	1		2		3	
Requesting help						
1. Please help me go to the nearest convenience store.						
2. Please help me go to the nearest toilet.						
3. Please take me to the vegetarian restaurant.						
4. Please help me go to my teacher's office.						
5. Please help me make a telephone call to my family.						
6. Please help me ask my family to be there.						
7. Please help me hand in homework to my teacher.						
8. Please take me to my school playground.						
9. Please take me to the nearest library.						
10. Please take me to the nearest health center.						
Accuracy & Action%						