Individuals with nonfluent aphasia (NA) typically exhibit sparse, agrammatic verbal output and impaired word finding (Basso, 2003; Spreen & Risser, 2003) For many, participation in speech-language rehabilitation with various therapeutic methods (behavior modification, cognitive therapy, pragmatic therapy) provides a means of regaining verbal skills. Others gain limited verbal output using these approaches, regardless of time post-stroke.

Augmentative and Alternative communication (AAC) is a means of communicating through devices/techniques when communication skills are not functional. AAC ranges from low-tech (pictures/drawings on board) to high-tech (computer with voice output) systems (Cook & Hussey, 2002). Scherer's (2002) multidimensional Matching Person and Technology (MPT) model emphasizes user's quality of life beyond device and disability, addressing competence, self-esteem, user personality, environment characteristics, and device features. The model is reliable and valid in determining factors impacting quality of life.

Some individuals with communication disorders benefit from assistive technology use to improve communicative effectiveness (Aftonmous et al., 1997; Fox & Fried-Oken, 1996; Garrett et al., 1989). Garrett et al. (1989) reported successful use of a multimodal augmentative approach with a Broca's aphasic individual, incorporating the adult's residual communicative capabilities. Weinrich et al. (1989) and others (Aftonomos et al., 1997; Weinrich et al., 1993; Weinrich et al., 1995; Weinrich et al., 1997a; 1997b) found that individuals with severe NA could be trained to use picture symbols to form sentences, using Lingraphica ® .

Limited research with computer-based therapy has revealed language improvement for aphasic individuals using symbols to communicate on speech output devices. In an efficacy study, chronic aphasic individuals generalized learned reading skills from a computer program to other language areas (Katz & Wertz, 1997). Wallesch and Johannsen-Horbach (2004) demonstrated improvement in aphasic adults' functional communication with combined clinical therapy and computer-based home training. In the only published AAC effectiveness study, performance of chronic NA individuals was superior to their natural language, using computer-based AAC intervention (Koul et al., 2005; Koul & Harding, 1998)

Individuals with chronic severe aphasia can learn to communicate through AAC using symbols. However, most studies are case studies, omitting strategies/techniques to facilitate generalization from therapy to daily communication. As functional communication using AAC appears attainable, a detailed, repeatable, and well-planned protocol documenting treatment outcome is needed. This study is a format for training 2 chronic NA adults to use computer-based AAC for functional communication.

Method

Two individuals (RE, HR) with severe NA, accompanying apraxia of speech (AOS), and right hemiparesis resulting from left CVAs participated (Table 1). Both passed hearing screenings (Ventry & Weinstein, 1983; 1992) and received traditional speech-language therapy since CVA.

Pre- post-testing: 1) Western Aphasia Battery (WAB) (Kertesz, 1982) Aphasia Quotient (AQ), Cortical Quotient (CQ); 2) American Speech-Language Hearing Association Functional Assessment of Communication Skills (ASHA FACS) (Frattali et al., 1995) to measure everyday communicative activities; 3) American Speech-Language Hearing Association Quality of Communication Life Scale (ASHA QCL) (Paul et al., 2003), examining impact of communication disorder from perspective of communicatively-impaired person; and 4) Communicative Effectiveness Index (CETI) (Lomas et al., 1989), caregiver rating of situations

important to aphasic individual and their caregiver.

A device was chosen based on features desirable for chronic aphasia. The Dialect by Zygo with Speaking Dynamically Pro was chosen for easy accessibility (touch screen), portability, and speech synthesizer (Zygo Industries, Inc., 2004). Photographs can be downloaded to use with orthographic symbols.

An interview session was conducted in which caregiver and aphasic individual provided information on interests, hobbies, activities, friends/ family, etc., which was used to tailor the device to the individual. Photographs were used to identify family/friends in place of orthographic symbols. Device symbols were organized into categories following general to specific hierarchy structure. Number of choices at each level varied from 2 to 13 symbols per screen, depending on participant ability and information provided during interview.

Caregivers received AAC training including overview on navigating different symbol levels and the hierarchy structure. Instructions were provided on facilitation strategies and hierarchy of cues/prompts to use with participants while incorporating device use outside of therapy. The training procedure for aphasic participants was similar to Koul et al. (2005). Device training was 1 hour, 4 days weekly per participant.

First stage was symbol identification. At each level, the individual was required to identify each symbol on the display correctly given spoken instruction, 4 of 5 trials without cues/prompts. Prompt/cue sequence (Koul et al., 2005) used during training is in Table 2. When criterion was reached, the individual moved to the next level until all symbols were correctly identified in 4/5 trials without cues/prompts. If participants were unable to identify a particular symbol, it was adjusted to ensure better association between symbol and meaning.

The second stage involved navigating to the correct category to choose a symbol requested by the clinician. This stage evolved into the third stage, scenario role-play. Participants were asked questions about their daily schedule. Cues/prompts were provided (Table 2) until participants could provide logical answers independently. To ensure responses were the intended meaning, caregivers filled out questionnaires before each session. When participants provided logical one-symbol answers to 8/10 questions from each setting without cues/prompts, they proceeded to the next phase, which trained answering questions about everyday activities/interests with short sentences using symbols.

Results:

Results revealed improvement in both individuals' CQ (WAB) (Table 3), often considered a measure of intelligence. RE's AQ did not change; however, HR displayed marked AQ improvement. Greatest areas of improvement for both were in Reading, Writing, and Praxis tasks; HR also improved in Naming.

Measurement of communicative activities (ASHA FACS) (Table 4) revealed that communicative independence improved for both participants. RE's and HR's greatest improvements were in social communication and daily planning, respectively. ASHA QCL (Table 5) did not change for either participant. Both ranked initial perception of communication ability high. Caregivers' perception of communication (CETI) (Table 6) indicated improvement in social interactions (one-on-one communication, responding without words). HR's caregiver noted improvement in all areas, including more word use to communicate.

Symbol identification entailed16 sessions for both participants (Table 7). RE progressed to third symbol level with 83% accuracy; HR remained at level two, needing maximum cuing (10 sessions). Both moved to navigation (session 20), which entailed frequent cuing evolving

into role-play; RE and HR required 24 and 13 sessions, respectively. RE had difficulty remembering which category to choose on fourth level during navigation. RE's board was adjusted for easier navigation (session 30), resulting in accuracy increases in role-play through session 40. HR moved from transition stage to role-play with 100% accuracy (session 25), remaining on sentence formation through session 40.

Discussion

Results revealed that chronic NA individuals used an AAC device to improve communication skills in all settings (Koul et al., 2005; Koul & Harding, 1998). Findings showed improvement in language and cognitive functioning for both participants (Katz & Wertz, 1997). The device was accessible, portable, and allowed content programming related to the individual (MPT) (Scherer, 2002). Thus, participants learned device use, generalizing from therapy to daily activities with opportunities provided by clinician and caregivers (Cook & Hussey, 2002). Participant's perception of communication did not change, due to high initial perceptions and extended time post-stroke; participants felt they were communicating to the best of their abilities. Caregivers' perceptions increased in conjunction with improved communicative independence.

The training procedure with Dialect enhanced functional communication in all settings. Training length and specificity for stages was outlined for attainable goals/strategies for both patient and caregiver to facilitate generalization.

References

Aftonomos, L. B., Steele, R. D., & Wertz, R. T. (1997). Promoting recovery in chronic aphasia with an interactive technology. *Arch Phys Med Rehabil, 78*(8), 841-846.

Basso, A. (2003). *Aphasia and its Therapy.* Oxford, NY: Oxford University Press, Inc.

Cook, A.M., & Hussey, S.M. (2002). *Assistive Technologies: Principles and Practice* (2nd ed., Rev.). St. Louis, MS: Mosby, Inc.

Fox, L. E., & Fried-Oken, M. (1996). Aac aphasiology: Partnership for future research. *Augmentative & Alternative Communication, 12*(4), 257.

Frattali, C. M., Thompson, C. M., Holland, A. L., Wohl, C. B. and Ferketic, M. M. (1995) *ASHA Functional Assessment of Communication Skills (FACS)*. (Rockville, MD: American Speech-Language-Hearing Association).

Garrett, K. L., Beukelman, D. R., & Low-Morrow, D. (1989). A comprehensive augmentative communication system for an adult with broca's aphasia. *Augmentative & Alternative Communication, 5*(1), 55.

Katz, R. C., & Wertz, R.T. (1997). The efficacy of computer-provided reading treatment for chronic aphasiac adults. *Journal of Speech, Language and Hearing Research,* 40, 493-507.

Kertesz, A. (1982). *Western Aphasia Battery*. New York: Grune and Stratton.

Koul, R., Corwin, M., & Hayes, S. (2005). Production of graphic symbol sentences by individuals with aphasia: Efficacy of a computer-based augmentative and alternative communication intervention. *Brain Lang, 92*(1), 58-77.

Koul, R., K., & Harding, R. (1998). Identification and production of graphic symbols by individuals with aphasia: Efficacy of a software application. *Augmentative & Alternative Communication, 14*(1), 11.

Lomas, J., Pickard, L., Bester, S., Elbard, H., Finlayson, A., & Zoghaib, C. (1989). The Communicative Effectiveness Index: development and psychometric evaluation of a functional communication measure for adult aphasia*. Journal of Speech and Hearing Disorders*, *54*, 113-124.

Paul, D.R., Frattali, C.M., Holland, A.L., Thompson, C.K., Caperton, C.J., & Slater, S.C., (2003). *ASHA Quality of Communication Life Scale (QCL)*. Rockville, MD: American Speech-Language-Hearing Association.

Scherer, M. J. (Ed.). (2002). *Assistive technology: Matching device and consumer for successful rehabilitation.* Washington, DC: American Psychological Association.

Spreen, O., & Risser, A.H. (2003). *Assessment of Aphasia*. Oxford, NY: Oxford University Press, Inc.

Ventry, I.M. & Weinstein, B.E. (1983). Identification of elderly people with hearing problems. *American Speech-Language-Hearing Association*, 25(7), 37-42.

Ventry, I. & Weinstein, B. (1992). Considerations in screening adults/older persons for handicapping hearing impairments. *American Speech-Language-Hearing Association,* 34, 81-87.

Wallesch, C.W., & Johannsen-Horbach, H. (2004). Computers in aphasia therapy: effects and side-effects. *Aphasiology,* 18(3), 223-228.

Weinrich, M., McCall, D., Shoosmith, L., Thomas, K., Katzenberger, K., & Weber, C. (1993). Locative prepositional phrases in severe aphasia. *Brain Lang, 45*(1), 21-45.

Weinrich, M., McCall, D., & Weber, C. (1995). Thematic role assignment in two severely aphasic patients: Associations and dissociations. *Brain Lang, 48*(2), 221-237.

Weinrich, M., Shelton, J. R., Cox, D. M., & McCall, D. (1997a). Remediating production of tense morphology improves verb retrieval in chronic aphasia. *Brain Lang, 58*(1), 23-45.

Weinrich, M., Shelton, J. R., McCall, D., & Cox, D. M. (1997b). Generalization from single sentence to multisentence production in severely aphasic patients. *Brain Lang, 58*(2), 327-352.

Weinrich, M., Steele, R. D., Carlson, G. S., Kleczewska, M., Wertz, R. T., & Baker, E. (1989). Processing of visual syntax in a globally aphasic patient. *Brain Lang, 36*(3), 391-405.

Zygo. (2004) Dialect with Speaking Dynamically Pro, Boardmaker, and SAPI speech synthesis, Zygo Industries, Inc.

Table 1. Participant Demographics

	Age	Gender	Years Education	Years post-stroke	Type of Aphasia	Degree of Severity
RE	57	Female	16	7:9	Mixed	Severe
HR	69	Male	21	3:2	Broca	Severe

Table 2. Prompt/Cue Protocol

Cue	Example
1. Verbal model + demonstration	Demonstrate how to access the symbol while providing verbal instruction
2. Verbal cues + pointing + gestures	Show symbol, point to symbol, say name of symbol & use sign for symbol meaning (if available)
3. Yes/No Questions	Is this a picture of _____?
4. Question the identity of the picture	Demonstrate how to access the symbol. Then show a picture/object
5. Preparatory set	Find each symbol in a string 1 at a time
6. State prompt + silent demonstration	Silently demonstrate how the question can be answered
7. State prompt + verbally and manually demonstrate	Verbally demonstrate how question can be answered

Table 3. Pre and post-testing: Western Aphasia Battery

WAB	RE		HR	
	Pre	Post	Pre	Post
Total Score				
Aphasia Quotient	26.4	26.3	23.5	32.3
Cortical Quotient	28.72	32.1	33.35	45.75
Differential				
Aphasia Quotient	-0.1		+8.8	
Cortical Quotient	+3.38		+12.4	

Table 4: Pre and post-testing: ASHA FACS

ASHA FACS	RE			HR		
	Pre	Post	DIFF	Pre	Post	DIFF
Communication Independence Scales						
Social Communication	2.7*	3.9	+1.2	3.91	4.3	+0.39
Communication of Basic Needs	5.9	6.3	+0.4	5.86	7	+1.14
Reading, Writing, Number Concepts	1.4	1.8	+0.4	3.2	4.6	+1.4
Daily Planning	3	2.4	-0.6	2	5	+3.0
Overall	3	3.6	+0.6	2.25	5.2	+2.95

*Ratings based on 7-point rating scale (1-7)

Table 5. Pre and post-testing: ASHA Quality of Communication Life Scale

	RE		HR	
	Pre	Post	Pre	Post
ASHA QCL				
Mean Score Overall	3.71*	3.63	4.24	4.8
Overall Rating	5.0	3.0	5	5
Differential				
Mean Score Overall	-0.08		+0.56	
Overall Rating	-2.0		0	

* Ratings based on a 5 -point rating scale (1-5)

Table 6. Pre and post-testing: CETI

Question	RE			HR		
	Pre	Post	DIFF	Pre	Post	DIFF
1. Getting somebody's attention.	7.3*	8.3	+1.0	2.8	8.8	+6.0
2. Getting involved in group conversations that are about him/her.	4.5	0.75	-3.75	1.0	5.0	+4.0
3. Giving yes and no answers appropriately.	6.25	8.2	+1.9	1.1	5.3	+4.2
4. Communicating his/her emotions.	5.4	5.9	+0.5	1.0	5.0	+4.0
5. Indicating that he/she understands what is being said to him/her.	6.1	5.4	-0.70	3.7	7.8	+4.1
6. Having coffee-time visits and conversations with friends and neighbors.	4.5	3.2	-1.3	0.2	4.4	+4.2
7. Having a one-to-one conversation with you.	3.5	1.5	+2.0	0.3	2.1	+1.8
8. Saying the name of someone whose face is in front of him/her	4.0	1.9	-2.1	0.2	1.8	+1.6
9. Communicating physical problems such as aches and pains.	5.25	5.2	-0.05	0.9	3.6	+2.7
10. Having a spontaneous conversation.	1.6	1.0	-0.6	0.2	0.2	0
11. Responding to or communicating anything without words.	5.6	7.6	+2.0	5.0	6.2	+1.2
12. Starting a conversation with people who are not close family.	2.45	1.5	-0.95	0.3	1.4	+1.1
13. Understanding writing.	3.5	6.2	+2.7	1.0	0.6	-0.4
14. Being part of a conversation when it is fast and there are a number of people involved.	2.55	0.7	-1.85	1.7	5.0	+3.3
15. Participating in a conversation with strangers.	0.2	1.3	+1.1	0.2	2.1	+1.9
16. Describing or discussing something in depth.	0.2	0.7	+0.5	0.2	0.2	0

* Ratings based on a 10 cm (point) analog rating scale (1-10)

Table 7. AAC Treatment Performance for Each Participant (every 5 sessions)

Training Session	Stage of Training		Accuracy	
	RE	HR	RE	HR
5	Symbol level 1	Symbol level 2	98%	72%
10	Symbol level 3	Symbol level 2	83%	100% **
15	Symbol level 4	Symbol level 3	92%	83%
20	Navigation	Navigation	66%	100%
25	Scenario Role-play	Scenario Role-play	100% *	100%
30	Scenario Role-play	Sentences	48%	81%
35	Scenario Role-play	Sentences	80%	86%
40	Scenario Role-play	Sentences	100%	96%
45	Sentence	NA	88%	NA

*1st day on this task. All trials included demonstration prior to independent trial.
**Maximum cuing needed.