Background

The characterization of aphasia as a pure linguistic deficit has constrained intervention research to singularly target language dysfunction (Connor, Albert, Helm-Estabrooks, & Obler, 2000). Recently this assumption has been called into question with the realization that traditional language models do not account for the variability of performance within and across people with aphasia, (Connor et al., 2000; Erickson, Goldinger, & LaPointe, 1996; McNeil, Odell, & Tseng, 1991; Tseng, McNeil, & Milenkovic, 1993). The limitations of purely linguistic models of aphasia have led researchers to evaluate the role of non-linguistic cognitive processes, particularly attention and working memory processes, in aphasia.

There is growing evidence that individuals with varying types and severities of aphasia exhibit deficits on a variety of attention tasks even when these tasks do not have language demands (e.g., Caspari, Parkinson, LaPointe, & Katz, 1998; Korda & Douglas, 1997; Murray, 2002). This research, coupled with the inadequacies of traditional language models has led to expanded models of aphasia suggesting that some aphasic symptoms are a product of, or exacerbated by, attention impairments. For example, the resource allocation theory of attention in aphasia proposes that language deficits in aphasia results from insufficient capacity or allocation of attentional resources (McNeil et al., 1991).

Direct attention training (DAT) is based on the notion that attentional abilities can be improved by stimulating the attention system through repetitive drills to promote recovery of damaged neural circuits (Sohlberg & Mateer, 2001). While studies have evaluated the efficacy of DAT for individuals with traumatic brain injury (e.g., Sohlberg, McLaughlin, Pavese, Heidrich, & Posner, 2000), attention training for aphasia is a relatively new area of investigation.

Several studies provide preliminary evidence that individuals with aphasia demonstrate improvements in attention as a result of DAT (Sturm et al., 1997, Barker-Collo et al., 2009). Furthermore, research suggests that improvements in attention resulting from DAT correspond to improved language skills in auditory comprehension (Helm-Estabrooks, Connor, & Albert, 2000) and reading comprehension (Coelho, 2005; Mayer & Murray, 2002; Sinotte & Coelho, 2007). Coelho (2005) provided DAT for reading impairment in an individual with mild aphasia and reported corresponding improvements in reading comprehension, reading rate, and perceived effort. A follow-up study conducted by Sinotte and Coelho (2007) using a more intensive protocol for attention training yielded similar findings. The authors attributed the participants' changes in reading to improvement in the allocation of attentional resources rather than improvement in linguistic skills. While these studies establish proof of concept, they lack experimental control. Moreover, the attention training protocols utilized require further exploration and development, with regard to theoretical models of attention and working memory. Finally, research that builds on Coelho and Sinotte's work would benefit from the use of a standardized repeated measure. A reading probe that taps the processing demands associated with reading would be a useful repeated measure to evaluate the potential effects of direct attention training on reading comprehension. The current study attempted to address these concerns and further this line of inquiry.

Can APT-3 Improve Reading Impairment in Mild Aphasia?

The current study evaluated the effect of Attention Process Training-3 (APT-3) (Sohlberg & Mateer, 2010), an intervention that combines direct attention training with metacognitive facilitation for the treatment of reading comprehension in individuals with mild aphasia and concomitant reading impairment. A non-concurrent multiple baseline design was used to assess the functional relation between the intervention and improvements in reading rate and comprehension for four individuals with mild aphasia. Visual inspection of graphed performance data and a variation of Cohen's (Cohen, 1988) *d* statistic, as calculated by Busk and Serlin (1992), were used for data analysis. The Conners' Continuous Performance Test-II (Conners, 2000), the Test of Everyday Attention (Robertson, Ward, Ridgeway, & Nimmo-Smith, 1994), and the Gray Oral Reading Test were administered pre- and post-treatment in order to assess potential changes in attention, working memory, and reading related to the intervention. The authors hypothesized that an intervention package combining DAT and metacognitive facilitation would lead to improvements in reading comprehension in the participants with mild chronic aphasia and reading difficulties based on a resource allocation model of attention in aphasia (McNeil et al., 1991) and working memory theory related to reading comprehension and retention (Daneman & Carpenter, 1980; Just & Carpenter, 1992).

Four participants were recruited with a history of left hemisphere stroke and a diagnosis of mild aphasia. The independent variable consisted of eight-weeks of Attention Process Training-3 (Sohlberg & Mateer, 2010), which consists of attention drills and features designed to promote metacognitive or self-regulatory behavior, delivered for 30-40 minutes, four times a week. Tasks were selected to stimulate sustained attention, working memory, and executive attention. The rationale for choosing working memory tasks was based on the capacity constraint model of working memory (Daneman & Carpenter, 1980; Just & Carpenter, 1992), which suggests that like attention, working memory is a capacity limited system. The metacognitive aspect of the intervention package consisted of reviewing participants' performance data and eliciting their ratings of effort and motivation for each task. Promotion of self-regulatory behaviors was hypothesized to enhance resource allocation and the deliberate mobilization of attentional resources to the task.

Repeated measures for reading rate and reading comprehension were obtained using eighth grade level "Standard Maze Passages" developed by *AIMSWeb* (Shinn & Shinn, 2002). Maze reading is a standardized, curriculum based assessment that is used to identify reading difficulties, monitor progress, and make program evaluation decisions for middle school students. The maze passages consist of a multiple-choice cloze task completed while reading silently. Maze reading has not been utilized as an assessment for individuals with aphasia and has the potential to be a powerful measure of reading comprehension for individuals experiencing reading difficulties subsequent to impairments in attentional and working memory.

Results and Discussion

Results demonstrated a functional relation between the APT-3 intervention and reading improvement, with robust treatment effects for two of the study's four participants. Of import, the maze test appeared to be a valid and sensitive measure of reading comprehension in individuals with mild aphasia and concomitant reading difficulties and offers an assessment that can be administered repeatedly. Additionally, there were improvements on select standardized measures of attention and working memory for all four participants. As illustrated in Figures 4 and 5, visual inspection of plotted data reveals notable improvements in maze reading from baseline to treatment phases that are maintained months after the intervention is completed for participants, GRCA and ADRI. Probe data from baseline and maintenance phases were also analyzed to quantify the magnitude of the change in level of performance using a variation of Cohen's (1988) *d* statistic, calculated by Busk and Serlin (1992). The change in reading performance from pre to post-treatment was appreciable for both GRCA (d = 2.46) and ADRI (d = 2.58), though small in magnitude according to benchmarks for effect size in aphasia treatment research recently proposed by Robey and colleagues (Robey, Schultz, Crawford, & Sinner, 1999). No changes in reading comprehension were observed from baseline to post-treatment in the other two participants (see Figures 6 and 7).

The two responders and two non-responders shared several significant characteristics leading to hypotheses about candidacy for this intervention package. These hypotheses along with recommended future research will be shared.

Figures

Figure 1. Sample APT-3 visual sustained attention task

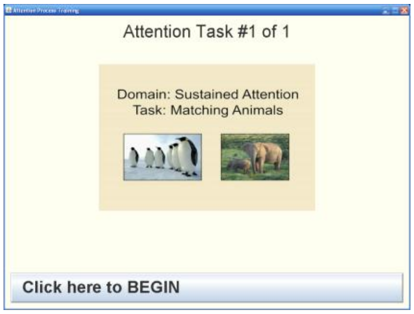


Figure 2. Effort and Motivation Ratings from APT-3

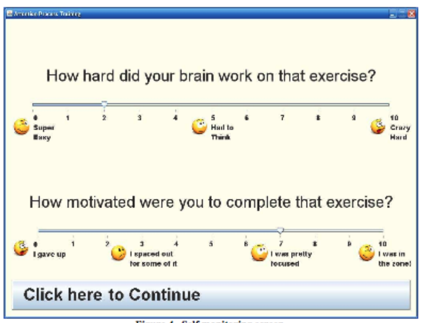


Figure 4. Self monitoring screen.

Figure 3. Reviewing Task Performance from APT-3

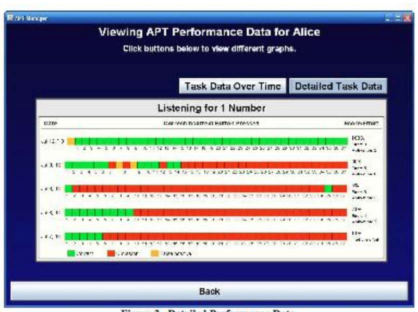


Figure 3. Detailed Performance Data.

Figure 4. Probe data for maze reading passage for baseline, treatment and maintenance sessions for GRCA.

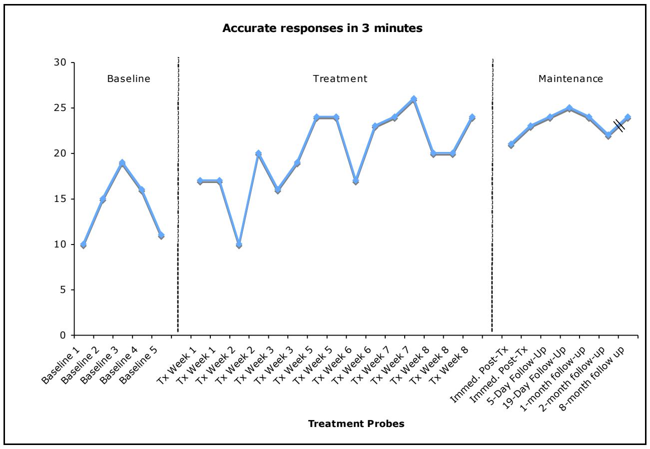


Figure 5. Probe data for maze reading passage for baseline, treatment and maintenance sessions for ADRI.

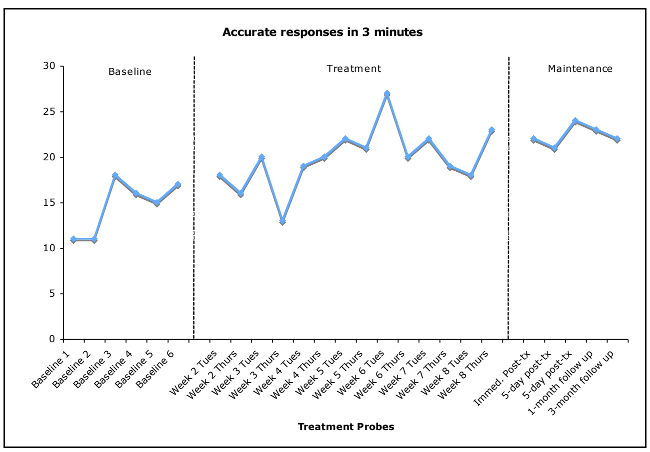


Figure 6. Probe data for maze reading passage for baseline, treatment and maintenance sessions for PORO.

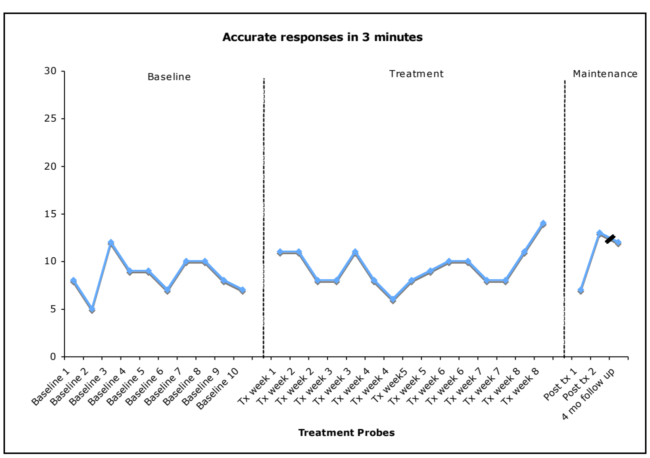
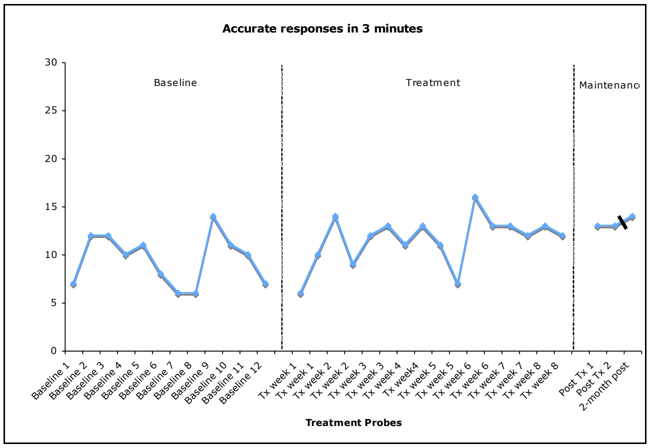


Figure 7. Probe data for maze reading passage for baseline, treatment and maintenance sessions for SVLA.



Select References

Busk, P. L., & Serlin, R. C. (1992). Meta-analysis for single case research. In T. R. Kratochwill & J. R. Levin (Eds.), *Single-Case Research Design and Analysis* (pp. 197-198). Hillsdale, NJ: Lawrence Erlbaum Associates.

Caspari, I., Parkinson, S. R., LaPointe, L. L., & Katz, R. C. (1998). Working memory and aphasia. *Brain Cogn, 37*(2), 205-223.

Coelho, C. A. (2005). Direct attention training as a treatment for reading impairment in mild aphasia. *Aphasiology, 19*(3-5), 3-5.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2 ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Conners, C. K. (2000). *Conners' Continuous Performance Test II*. Toronto: Multi-Heath Systems Inc.

Connor, L. T., Albert, M. L., Helm-Estabrooks, N., & Obler, L. K. (2000). Attentional modulation of language performance. *Brain Lang, 71*(1), 52-55.

Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. [doi: DOI: 10.1016/S0022-5371(80)90312-6]. *Journal of Verbal Learning and Verbal Behavior, 19*(4), 450-466.

Erickson, R. J., Goldinger, S. D., & LaPointe, L. L. (1996). Auditory Vigilance in Aphasic Individuals: Detecting Nonlinguistic Stimuli with Full or Divided Attention. [doi: DOI: 10.1006/brcg.1996.0016]. *Brain and Cognition, 30*(2), 244-253.

Helm-Estabrooks, N., Connor, L. T., & Albert, M. L. (2000). Treating attention to improve auditory comprehension in aphasia. *Brain and Language, 74*, 469-472.

Just, M. A., & Carpenter, P. A. (1992). A capacity theory of comprehension: individual differences in working memory. *Psychol Rev, 99*(1), 122-149.

Korda, R. J., & Douglas, J. M. (1997). Attention deficits in stroke patients with aphasia. *Journal of Clinical and Experimental Neuropsychology, 19*(4), 525 - 542.

Mayer, J. F., & Murray, L. L. (2002). Approaches to the treatment of alexia in chronic aphasia. *Aphasiology, 16*(7), 727 - 743.

McNeil, M. R., Odell, K., & Tseng, C. H. (1991). Toward the integration of resource allocation into a general theory of aphasia. *Clinical Aphasiology, 20*, 21-39.

Murray, L. L. (2002). Attention deficits in aphasia: Presence, nature, assessment, and treatment. *Semin Speech Lang, 23*(02), 107-116.

Robertson, I. H., Ward, T., Ridgeway, V., & Nimmo-Smith, I. (1994). *The Test of Everyday Attention*. Bury St. Edmunds, UK: Thames Valley Test Co.

Robey, R. R., Schultz, M. C., Crawford, A. B., & Sinner, C. A. (1999). Single-subject clinical-outcome research: designs, data, effect sizes, and analyses. *Aphasiology, 13*, 445-473.

Robin, D. A., & Rizzo, M. (1989). The effect of focal cerebral lesions on intramodal and cross-modal orienting of attention. *Clinical Aphasiology, 18*, 61-74.

Shinn, M. R., & Shinn, M. M. (2002). *Administration and Scoring of Reading Curriculum-Based Measurement for Use in General Outcome Measurement*. Eden Prairie, MN: Edformation.

Sinotte, M. P., & Coelho, C. A. (2007). Attention training for reading impairment in mild aphasia: A follow-up study. *NeuroRehabilitation, 22*(4), 303-310.

Sohlberg, M. M., & Mateer, C. A. (2001). *Cognitive rehabilitation: An integrative neuropsychological approach*. New York: Guilford Press.

Sohlberg, M. M., & Mateer, C. A. (2010). *Attention Process Training-3*: Lash & Associated Publishing/Training Inc.

Sohlberg, M. M., McLaughlin, K. A., Pavese, A., Heidrich, A., & Posner, M. I. (2000). Evaluation of Attention Process Training and Brain Injury Education in Persons with Acquired Brain Injury. *Journal of Clinical and Experimental Neuropsychology, 22*(5), 656 - 676.

Tseng, C. H., McNeil, M. R., & Milenkovic, P. (1993). An Investigation of Attention Allocation Deficits in Aphasia. [doi: DOI: 10.1006/brln.1993.1046]. *Brain and Language, 45*(2), 276-296.