Treating acquired alexia and cognitive impairment: Does attention training augment a text-based treatment protocol?

Researchers have developed and implemented a number of treatment protocols for acquired dyslexia; the bulk of these, motivated by cognitive neuropsychological models, are directed at the single-word level (cf. Beeson & Henry, 2008) and have suffered from lack of generalization to functional reading contexts.

Only a handful of reading treatments have been designed for reading of connected text. A seminal study by Moyer (1979) examined Multiple Oral Re-reading (MOR), a treatment technique in which patients read aloud the same text repeatedly over a period of days or weeks. Moyer's positive results have been replicated in a number of studies and with a variety of aphasia/alexia types and severities (e.g., Beeson et al., 2005). Cherney and colleagues (e.g., Cherney, 2010) have developed a similar treatment protocol, Oral Reading for Langauge in Aphasia (ORLA), which also entails reading aloud of given text. ORLA differs from MOR in that it follows a more structured, multi-modality stimulation approach (Cherney, 2004), by which the patient first listens to target text read aloud by the clinician, then reads the same text in unison with the clinician, and finally reads the text aloud independently. Both MOR and ORLA have been shown to facilitate generalization of within-treatment gains to new, unpracticed text-based material (Beeson, 1998).

A growing volume of research has established nonlinguistic cognitive deficits in individuals with aphasia (cf. Murray, 2002). It is possible that individuals with acquired alexia and aphasia, therefore, experience reading difficulties due at least in part to cognitive deficits (Mayer & Murray, 2002). Several studies have addressed directly treating cognitive skills to improve text-level decoding skills (Coelho, 2005; Mayer & Murray, 2002; Sinotte & Coelho, 2007). While these studies reported improvement following cognitive training, their designs disallowed determining whether more conventional, text-based treatment protocols might have yielded similar results.

The current study compared directly text-based with cognitive treatment for acquired alexia. It was hypothesized that the addition of attention training to purely text-based reading treatment would augment functional treatment outcomes for decoding accuracy, rate and comprehension. A secondary purpose was to replicate previous treatment studies demonstrating that acquired alexia responds to focused treatment with text-level and/or attentional protocols.

Methods

Participant. KO is a 28-year-old right handed female who was completing her third year of an MD-PhD program when she suffered a series of cerebrovascular accidents in the distribution of the left middle cerebral artery and the anterior communicating artery, with resultant bifrontal and left temporal infarcts. She was diagnosed with Moyamoya disease, and underwent left and right encephaloduroarteriosynangiosis (EDAS) at one and four months post-onset, respectively.

KO completed intensive speech therapy through twelve months post-onset, at which point, desperately wanting to return to school in some capacity, she sought additional therapy for her alexia.

Pre-Treatment Assessment. Following IRB approval and informed consent, KO completed an initial test battery examining oral and written language, attention, memory, and executive function skills in February 2010 (Table 1). Tests revealed deficits ranging from mild to severe across all cognitive domains with concomitant anosodiaphoria. Written language assessment was consistent with moderate, deep alexia (Marshall & Newcombe, 1973), with a "whole-word" approach to reading, poor letter-to-sound conversion, and impaired access to the orthographic lexicon (seeTable 2), with inconsistent comprehension of paragraph-level material up to about the 3rd grade level.

Study Design. A single-subject, multiple-phase (A-B-BC-A) treatment design was employed. Reading rate, decoding accuracy, and reading comprehension were regularly probed to examine the effects on reading proficiency of a text-level reading treatment alone versus supplementating that protocol with direct attention training. A verbal fluency task served as a control probe. General treatment phases, established on a pre-determined timeline, were as follows:

Phase A (3 sessions): Baseline
Phase B (7 sessions): Reading treatment
Phase BC (7 sessions): Reading treatment + direct attention training
Phase A (5 sessions): Return to baseline

Probe Tasks. A paragraph-level oral reading task was administered weekly to monitor decoding accuracy, rate, and comprehension. Materials were modified from two third-grade level workbooks (Evan-Moore Educational Publishers, 2003), and a different passage was used each week, with stimuli roughly equated for length (*m* = 237, *SD* = 43, range = 173-288 words) and complexity (calculated using the Flesch-Kincaid grade-level formula (Kincaid et al., 1983) (*m* = 3.6, SD = .31, range = 3.2-4.1).

Treatment Protocol. KO received one, 90-min. treatment session per week for 14 weeks, with the first seven sessions devoted exclusively to a text-level reading treatment (ORLA; Cherney, 2010) and the second seven sessions devoted to both the reading treatment (approx. 20 min) and direct attention training (APT; Sohlberg & Mateer, 1986; approx 60 min.). KO completed daily homework, designed to mimic treatment sessions, for one hour each day, divided into multiple sessions as needed according to her ability to maintain attention.

Results

Within treatment performance: KO progressed quickly through the first several levels of ORLA, and achieved 100% accuracy during choral reading at the 50-100 word level by week 8 (i.e., during treatment Phase BC). Notably, KO's decoding accuracy for ORLA stimuli remained high (80-90%) even when reading aloud independently (i.e., following the words highlighted by the computer but with the choral reading muted). By comparison, KO's progress on the APT protocol was slow, with a full seven treatment sessions required to meet criterion for all of the sustained attention exercises.

Probe performance. KO's decoding accuracy and rate yielded effect sizes (ES) of 1.7 and 6.2, respectively, from pre- to post-treatment (Figures 1 and 2, respectively). We used a time-series analysis, the *C* statistic (Tryon, 1982, 1984) to examine the slope of KO's decoding accuracy and rate across treatment phases. This analysis yielded a significant change in slope for reading accuracy (*C* = .77, z = 2.7, *p* = .003) from Phase A (baseline) to Phase B (ORLA), but not from Phase B to BC (ORLA + APT) (*C* = .11, z = .31, NS), and, using the trended residuals method described by Tryon (1982) to account for a rising baseline in reading rate, significant change in reading rate from Phase A to B (*C* = .65, z = 1.85, *p* = .032) and Phase B to BC (*C* = .63, z = 1.8, *p* = .036). Because KO's reading comprehension remained highly variable (25-80% accuracy) throughout the treatment protocol, we did not subject these data to statistical analysis. Verbal fluency performance was stable throughout and following treatment.

Standardized testing. Postitive gains in reading probe measures were supported by changes in decoding accuracy, rate and comprehension on the GORT-4 post-treatment (Table 1).

Discussion

Our data partially support previous research demonstrating the utility of attention training (APT) for acquired alexia, but our results are more consistent with the positive effect of a text-level reading treatment, ORLA, and/or with positive effects of repeated probing, above and beyond that of APT alone. We explore clinical and theoretical implications of these data, including the need for a minimal level of reading competency prior to implementing APT and/or text-level protocols.

Selected References

Beeson, P. M. (1998). Treatment for letter-by-letter reading: A case study. In: N. Helm-Estabrooks & A. L. Holland (Eds.), *Approaches to the Treatment of Aphasia* (pp. 153-177). San Diego, CA: Singular Press.

Beeson, P. M., & Henry, M. L. (2008). Comprehension and production of written words. In: R. Chapey (Ed.), *Language intervention strategies in adult aphasia* (5th ed.). Baltimore, MD: Lippincott, Williams & Wilkins.

Beeson, P. M., & Insalaco, D. (1998). Acquired alexia: Lessons from successful treatment. *Journal of the International Neuropsychological Society, 4*, 621–635.

Beeson, P. M., Rising, K., Kim, E. S., & Rapcsak, S. Z. (2010). A treatment sequence for phonological alexia/agraphia. *Journal of Speech, Language, and Hearing Research, 53*, 450-468.

Beeson, P. M., Magloire, J. G., & Robey, R. R. (2005). Letter-by-letter reading: Natural recovery and response to treatment. *Behavioral Neurology, 16(4)*, 191-202.

Brown, L., Sherbenou, R. J., & Johnsen, S. K. (1997). *Test of Nonverbal Intelligence – Third Edition (TONI-3).* Austin, TX: Pro-Ed.

Cherney, L. R. (2004). Aphasia, alexia, and oral reading. *Topics in Stroke Rehabilitation, 11(1)*, 22-36.

Cherney, L. R. (2010). Oral Reading for Language in Aphasia (ORLA): Evaluating the efficacy of computer-delivered therapy in chronic nonfluent aphasia. *Topics in Stroke Rehabilitation, 17(6)*, 423-431.

Cherney, L. R., Merbitz, C., & Grip, J. (1986). Efficacy of oral reading in aphasia therapy outcome. *Rehabilitation Literature, 47*, 112–118.

Coelho, C. (2005). Direct attention training as a treatment for reading impairment in mild aphasia. *Aphasiology, 19*, 275–283.

Delis, D. C., Kaplan, E., & Kramer, J. H. (2001). *Delis-Kaplan Executive Function System.* San Antonio, TX: The Psychological Corporation.

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

Kincaid, J. P., Braby, R., & Wulfeck, W. H. (1983). Computer aids for editing tests. *Educational Technology, 23*, 29–33

Lincoln, N. B., McGuirk, E., Mulley, G. P., Lendrem, W., Jones, A. C., & Mitchell, J. R. A. (1984). Effectiveness of speech therapy for aphasic stroke patients: A randomized controlled trial. *Lancet, 1*, 1197–1200.

Marshall, J., & Newcombe, F. (1980). The conceptual status of deep dyslexia. In: M. Coltheart et al. (Eds.), *Deep dyslexia.* London: Routledge & Kegan-Paul.

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

Moody, S. (1988). The Moyer reading technique re-evaluated. *Cortex, 24*, 473–476.

Moyer, S. (1979). Rehabilitation of alexia: A case study. *Cortex. 15*, 139–144.

Murray, L. L. (2002). Attention deficits in aphasia: Presence, nature, assessment and treatment. *Seminars in Speech and Language, 23*, 107–116.

Murray, L. L., Keeton, R. J., & Karcher, L. (2006). Treating attention in mild aphasia: Evaluation of Attention Process Training-II. *Journal of Communication Disorders, 39*, 37-61.

Palmese, C. A., & Raskin, S. A. (2000). The rehabilitation of attention in individuals with mild traumatic brain injury using the APT-II programme. *Brain Injury, 14*, 535-548.

Park, N. W., & Ingles, J. L. (2001). Effectiveness of attention rehabilitation after an acquired brain injury: A meta-analysis. *Neuropsychology, 15*, 199-210.

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.

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

Sohlberg, M. M., Avery, J., Kennedy, M., Ylvisaker, M., Coelho, C., Turkstra, L., et al. (2003). Practice guidelines for direct attention training. *Journal of Medical Speech-Language Pathology, 11*, xix-xxx.

Sohlberg, M. M., Ehlhardt, L., & Kennedy, M. (2005). Instructional techniques in cognitive rehabilitation: A preliminary report. *Seminars in Speech and Language, 26*, 268-279.

Sohlberg, M. M, & Mateer, C. A. (1986). *Attention Process Training (APT).* Puyallup, WA: Association for Neuropsychological Research and Development.

Tuomainen, J., & Laine, M. (1991). Multiple oral rereading technique in rehabilitation of pure alexia. *Aphasiology, 5*, 401–409.

Wiederholt, J., & Bryant, B. (2001). *Gray Oral Reading Tests* (4th ed.). Austin, TX: Pro-Ed.

Wilson, B. A., Greenfield, E., Clare, L., Baddeley, A., Cockburn, J., Watson, P., et al. (2008). *The Rivermead Behavioral Memory Test – Third Edition.* London, UK: Pearson.

Table 1. *Standardized testing results*

TEST	Subtest		Pre-treatment	Post-treatment
WAB	Aphasia Quotient		88.4	N/A
RCBA-2	IV Functional Reading		6/10	8/10
	VI Sentence-Picture		9/10	8/10
	VII Paragraph-Picture		7/10	5/10
GORT-4	Comprehension		Grade 3	Grade 5
	Fluency		Grade 1	Grade 1
PALPA				
	Nonword reading		6/24	7/24
	Single-word reading x frequency and imageability			
	Imageability	Frequency		
	High	High	14/20	20/20
	Low	High	13/20	16/20
	High	Low	16/20	15/20
	Low	Low	6/20	9/20
	Total		49/80	60/80
RBMT-3	General Memory Index		82	81
	Percentile Rank		12	10
TONI-3	Raw score		2	5
	Quotient		62	65
	Percentile		<1	5
DKEFS				
Trail Making Test	Visual Scanning		SS = 11	SS = 7
	Number Sequencing		SS = 3	SS = 4
	Letter Sequencing		SS = 1	SS = 1
	Number-Letter switching		SS = 1	SS = 1
	Motor Speed		SS = 12	SS = 12
Design Fluency	Composite		SS = 6	SS = 6
	Design Accuracy		SS = 1	SS = 1
Verbal Fluency	Letter Fluency		SS = 1	SS = 2
	Category Fluency		SS = 1	SS = 1
	Category Switching Total		SS = 1	SS = 1
	Category Switching Accuracy		SS = 3	SS = 3

Note. WAB = Western Aphasia Battery; RCBA-2 = Reading Comprehension Battery for Aphasia – 2nd Ed.; GORT-4 = Gray Oral Reading Test – 4th Ed.; PALPA = Psycholinguistic Assessment of Language Processing in Aphasia; RBMT = Rivermead Behavioral Memory Test; TONI-3 = Test of Nonverbal Intelligence – 3rd Ed., DKEFS = Delis-Kaplan Executive Function System.

Table 2. *Oral reading example*

Nonfiction Reading Practice, Grade 3

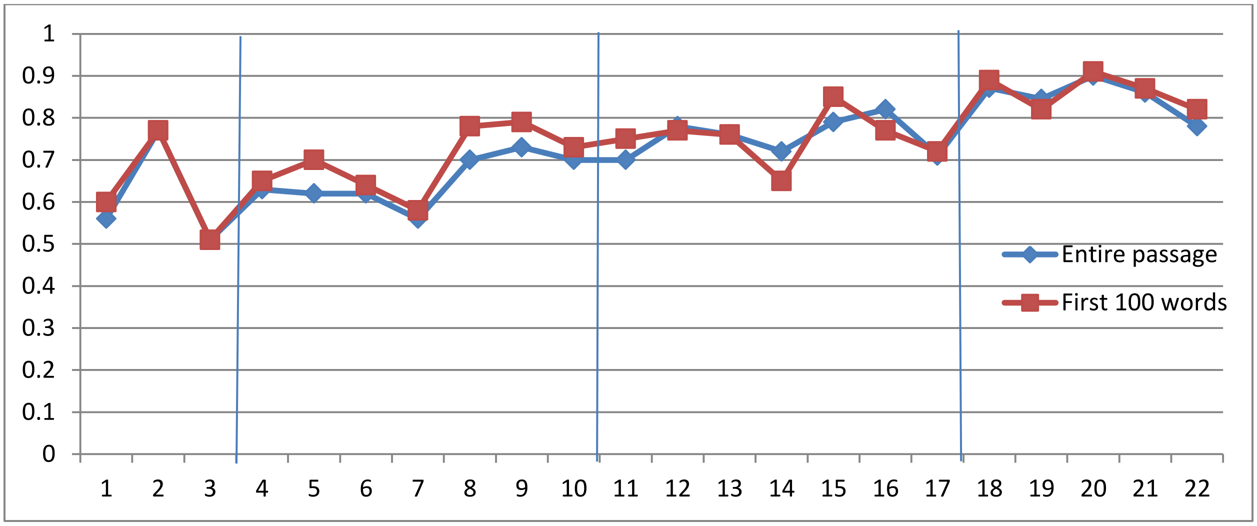
“Calendar Confusion”

Stimulus item	KO’s oral reading (errors are highlighted)
Calendar history can be confusing. Ancient people did not know that Earth moves around the sun. They tried to track the year by counting the full moons.	Calendar history can be confused. Accent people do not know if Earth moved around the sun. They tried to take the year by continuing to fuel moons.
Each year had 12 full moons. Twelve moons, or months, made one lunar year.	Each year there’s 20 full moons. The moons, or months, made one linear year.
Calendars in Babylon used a lunar year. Twelve lunar months equaled about 354 days.	Calendars in Babylonian used a linear year. Twelve linear months equals about 347 years.
Earth really moves around the sun in about 365 days. That made the lunar year 11 days too short. After a few years, the seasons and months no longer matched up.	Earlier moves around the sun in about 367 days. They made the linear year 12 days too short. After a new years, the seasons and months no longer matched up.
The Egyptians came up with a solar calendar. It gave the year 365 days. It divded the year into 12 months. That was a lot less confusing.	The Egyptians came up with a sour calendar. It gave the year 365 days. It divided the year into 12 months. That was a lot less confusing.
Too bad the Romans did not use that calendar. Theirs had 10 months and 304 days. Pretty soon, holidays were showing up at the wrong time of year.	Too bad the Romans did not use that calendar. Theirs had 12 months and 304 days. Pretty soon, history was shown to at the wrong time of year.
They added 51 days, but that wasn’t enough. Their calendar was still 10 days short. Romans began to scratch their heads and wonder why winter was showing up in spring.	They added 51 days, but that wasn’t enough. The calendar was still 10 days short. Romans began to chat their heads and wonder why winter was short up in spring.

Figure Captions

Figure 1. Treatment probe data for KO's decoding accuracy (calculated as a percentage) for baseline (1-3), ORLA (4-10), ORLA + APT (11-17), and follow-up (18-22) phases.

Figure 2. Treatment probe data for KO's reading rate (measured in seconds per word), for baseline (1-3), ORLA (4-10), ORLA + APT (11-17), and follow-up (18-22) phases.



1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Entire passage
First 100 words

Figure 1.

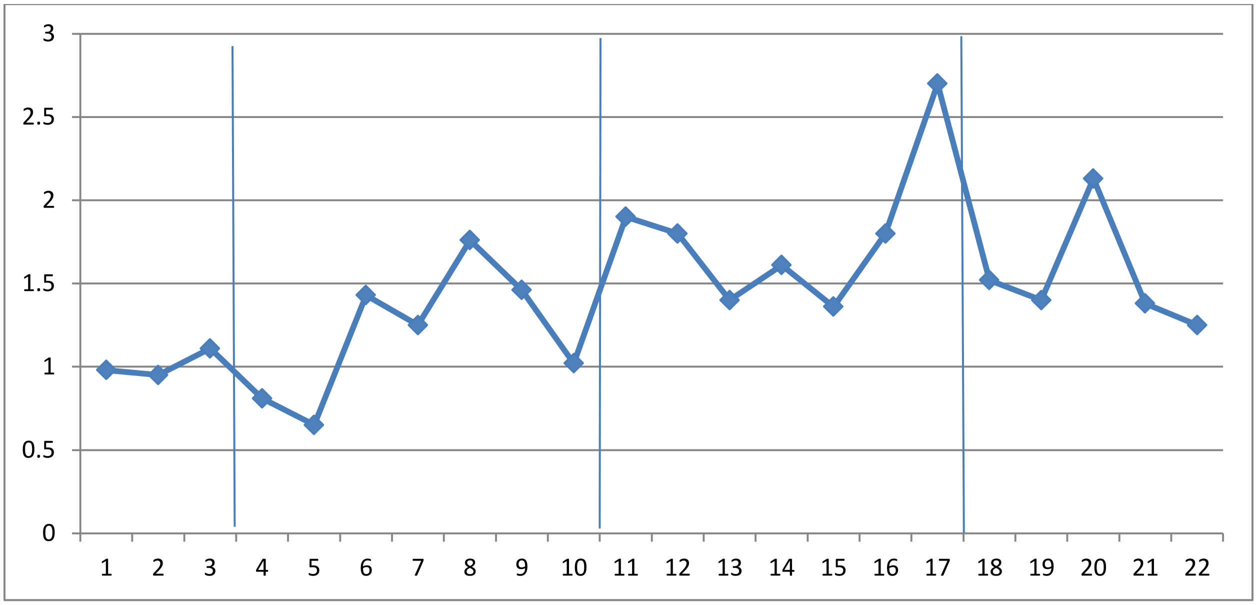


Figure 2.