Intensity of speech-language therapy (SLT) is an important component of any aphasia intervention. Studies have indicated that the more intense and frequent the speech-language treatment, the better the outcome. Intensive SLT has been associated with significant improvements (Pulvermuller et al., 2001; Meinzer et al, 2005). Additional support for more intensive SLT was demonstrated in a retrospective analysis of 10 studies investigating aphasia therapy after stroke (Bhogal et al., 2003). Five studies with a significant treatment effect provided an average of 8.8 hours (5-10) of treatment per week for an average of 11.2 weeks (8-12). Five negative studies provided only about 2 hours (2-3.8) of SLT per week for 22.9 weeks (20-26). These findings are consistent with those of Robey (1998), who, in a meta-analysis of clinical outcomes in aphasia treatment, also revealed that the more intensive the therapy the greater the improvement. While the evidence certainly suggests that intense SLT over a shorter amount of time is more beneficial, no well-designed prospective randomized clinical trial has directly addressed this question.

The purpose of this study is to compare high-intensity (10-hours per week) versus low-intensity (4-hours per week) aphasia treatment. However, intensive therapy is costly. An effective and economical option for delivering SLT at high intensity is via computer. Therefore, for this study, a computer version of an aphasia treatment technique that has previously been shown as efficacious when delivered by a speech-language pathologist, was developed.

More specifically, the purpose of this randomized single-blind study was to:
1) assess the efficacy of a treatment, Oral Reading for Language in Aphasia (ORLA), when provided via computer
2) evaluate the effects of treatment intensity by comparing high-intensity versus low-intensity Computer ORLA (C-ORLA)

METHODS

Subjects:
Forty-seven individuals with nonfluent aphasia following a single left-hemisphere ischemic stroke occurring more than 6 months previously participated. No subjects presented clinically with global aphasia. All subjects were right handed, with at least a 12^{th} grade education.

Subjects comprised three groups. Twenty-two subjects were recruited prospectively and randomized into either 4-hours or 10-hours of C-ORLA treatment per week. Twenty-five subjects who had participated in a previous study served as no-treatment controls. Table 1 shows demographic data for the three groups of subjects. Groups were equivalent on age, months post onset, and severity of aphasia as determined by the Aphasia Quotient of the Western Aphasia Battery.

Treatment:

Oral Reading for Language in Aphasia (ORLA) is a technique in which the person with aphasia repeatedly reads aloud sentences and paragraphs, first in unison with the clinician, and then independently. ORLA focuses on connected discourse rather than single words, permitting the modeling of more natural rhythm and intonations. It also allows practice on a variety of grammatical structures, rather than just one specific grammatical form. Consistent with a stimulation approach, ORLA uses repetitive multimodality stimulation to elicit a response. It is also consistent with principles of learning theory (active participation by the learner, repetitive practice in the overlearning of skills, use of meaningful materials that are graded in difficulty).

C-ORLA is a computer version of ORLA. Using state-of-the-art computer technology, the program has an animated agent that serves as a virtual therapist. The animated agent produces natural speech with correct movements of the speech articulators, repeatedly reading aloud with the patient, in exactly the same way as a therapist would administer ORLA. Figure 1 shows examples of patient interface screens.

For the prospective group, patients were assessed pre-treatment, then randomized to either the 4-hour or 10-hour group. Subjects were trained on C-ORLA and laptops containing the program were loaned to them. Treatment lasted 6 weeks – patients. practiced at home independently, returning to see the speech-language pathologist once per week to ensure that practice was done correctly. Mechanisms to ensure compliance were developed. Log on and log off times were time stamped on the computer and lists of all stimuli that were practiced were generated and stored. In addition, subjects were asked to complete practice logs.

Subjects were reassessed immediately post-treatment. Additionally, for subjects randomized to the 10-hour group, an interim test session was scheduled following 24 hours of treatment, that is the same number of treatment sessions that the 4-hour group received after 6 weeks of treatment.

Outcomes. Speech and language recovery was measured with the Western Aphasia Battery – Aphasia Quotient (WAB-AQ). For the 4-hour treatment group, WAB AQ assessment occurred at baseline and following 6-weeks of treatment (after 24 treatment hours). For the 10-hour treatment group, WAB AQ assessment occurred at baseline, after 24 treatment hours, and following 6-weeks of treatment (after 60 treatment hours). The no-treatment control subjects were evaluated 6-weeks apart.

RESULTS

An intent-to-treat analysis was conducted on the data i.e. analyses were based on the group to which subjects were randomized.

Group data

1. The mean change in WAB AQ for all 22 C-ORLA subjects was 5.21 (SD= 6.88).

The mean change in WAB AQ for the 25 no-treatment control subjects was -0.86 (SD=3.54). The difference in WAB AQ change scores between treatment and control groups was significant ($p<.01$). See Figure 2.

2. Following 6-weeks of treatment, the mean change in WAB AQ score was 6.76 (SD=7.63) for the 10 hour group and 3.92 (std deviation 6.22) for the 4 hour group. The difference in WAB AQ change scores between the 4-hour and 10-hour treatment groups was not significant ($p>.05$).
3. Following 24 treatment sessions, the mean change in WAB AQ from pre-treatment to interim testing (i.e. after 24 sessions distributed over 2.5 weeks) in the 10-hour group was 1.66 (SD=4.94). This was not significantly different from the change made by the 4-hour treatment group after 24 sessions distributed over 6 weeks.

Individual subject data

For the 10-hour group, changes in WAB AQ scores ranged from -1.4 to 22.2 points, with 6 of 10 subjects improving more than 5 points. Amount of change was correlated with pre-treatment WAB AQ score ($r=0.61$), indicating that the more severe the aphasia, the greater the improvement. For the 4-hour group, changes in WAB AQ scores ranged from -3.40 to 15.5, with 4 of 12 subjects improving more than 5 points. There was no correlation between amount of change and initial severity based on pre-treatment WAB scores ($r=0.01$).

DISCUSSION AND CONCLUSIONS

C-ORLA may be an efficacious treatment for people with chronic nonfluent aphasia. Over the 6-week period, there was a trend for greater language improvement with increased intensity and amount of therapy. This was not unexpected since the 10-hour group received more treatment hours than the 4-hour groups. However, after 24 treatment hours for both the 4-hour and 10-hour groups, there was a trend towards greater improvement when sessions were scheduled less intensively. Thus there may be a critical amount and intensity of treatment that is required for maximum improvement. Different intensities of treatment may be preferable at different times during the learning process.

This study represents one of the largest randomized clinical trials in aphasia treatment to date. The study used an intent-to-treat analysis which is the recognized analysis to use in clinical trials. However, data was also analyzed from group assignment based on actual participant behaviors. These differences and the appropriateness of the intent-to-treat analysis for future aphasia treatment trials will be discussed.

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Table 1. Demographic data for 22 subjects randomized to either 4 or 10 hours of aphasia treatment and 25 no-treatment control subjects with aphasia (includes mean, standard deviation and range)

	4 hours / week	10 hours / week	Control Group
# Subjects	12	10	25
Male:Female	9:3	5:5	16:9
Age	55.57 (15.06) 31.35 – 77.98 yrs	56.54 (13.97) 25.83 – 74.50	58.2 (12.0) 35.18 – 79.64
Months post onset	50.70 (45.84) 7.3 - 159.8	37.84 (26.26) 7.6 – 77.3	54.0 (59.3) 12.2 - 253
Baseline WAB AQ	48.76 (22.18) 13.7 – 77.1	49.59 (19.37) 28.0 – 78.9	53.74 (25.34) 9.7 – 81.4

Figure 1. Examples of C-ORLA screens showing the animated agent. The patient reads sentences aloud in unison with the animated agent and then independently. Words are highlighted as the animated agent and patient read aloud together.

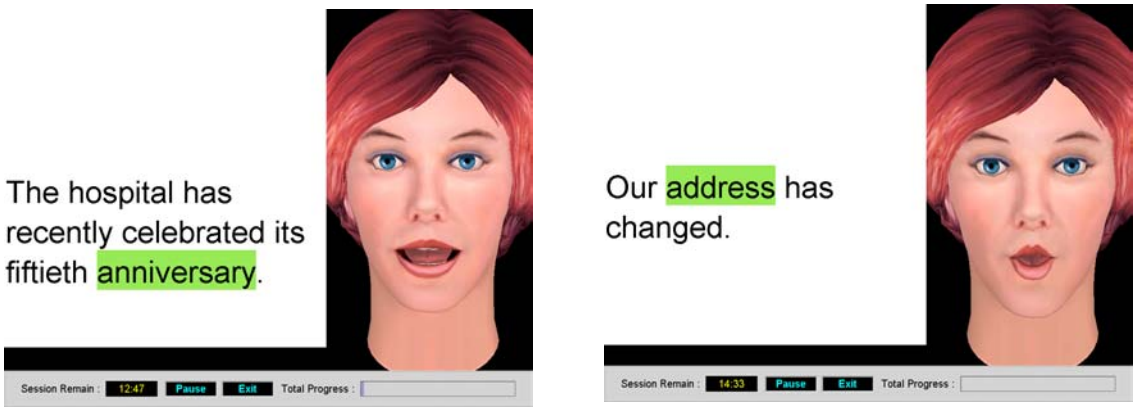

Figure 2. Mean Change in WAB –AQ Scores For Treatment Subjects Combined (N=22), No-Treatment Control Group (N=25), and the 4-hour and 10 hour Treatment Groups