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AMERICAN SPEECH-LANGUAGE-HEARING ASSOCIATION

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This course is offered for 0.05 ASHA CEUs (Introductory level; Professional area).

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Speech-language pathologists (SLPs) are invited to participate in a one-hour ASHA-approved course offering, "Improvements in Chronic Global Aphasia with Therapy and Online Home Practice." To be eligible to receive 0.05 ASHA CEUs (Introductory level), please see the guidelines below.

For more information about ASHA's most up-to-date eligibility criteria, go to the FAQ section of the ASHA CE website: http://www.asha.org/CE/FAQs/.

Course Description:

We discuss improvements in persons with chronic global aphasia following resumption of therapy with a clinical, computer-based program using structured interactive exercises. Participants learn where and at what magnitudes significant improvements occurs, at impairment and functional communication levels, according to Western Aphasia Battery and Communicative Effectiveness Index assessments.

Learning Outcomes:

By completing this course, participants will be able to:

1. Characterize the magnitudes of overall improvements documented among persons with chronic global aphasia following advanced structured therapy that includes computerized home practice.
2. Describe observed patterns between initial WAB and CETI assessment scores and final assignments to either global aphasia or Broca's aphasia.
3. Discuss the place of outcome studies such as this to the processes of improving clinical practice and identifying topics for follow-up on clinical study and experiment.

Additional courses in the Evidence-based Practice track include:

- Improvements in Chronic Conduction Aphasia with Advanced Therapy and Home Practice (Introductory, 0.1 ASHA CEUs)
- AAC Technology Design for Persons with Aphasia (Introductory, 0.1 ASHA CEUs)
- Maximizing Patient Outcomes by Leveraging Clinical Data from Online Therapy (Introductory, 0.05 ASHA CEUs)

Processing:

Online course completions are reported to ASHA quarterly. Please allow eight to ten weeks for processing. Lingraphica will issue a certificate of participation to each SLP who completes a CEU course.

For more information, or to start a device trial, contact: **continuinged@lingraphica.com**

Chronic Global Aphasia

I. CHARACTERISTICS

- Western Aphasia Battery Aphasia Quotient range: $0 \leq AQ < 26$
- Invariably exhibit severe impairments in all language functions
- Most cannot perform even the simplest tests of listening comprehension
- Most cannot reliably answer simple yes-no questions
- Few can read even simple words; none can read sentences functionally
- Speech most often consists of a few simple words or stereotypical phrases
- Most are nonetheless attentive, alert, task-oriented, and socially appropriate

II. TYPES

• *basic choice communicators*	require maximal assistance from partners
• *controlled situation communicators*	participate in conversations structured by a skilled communication partner
• *augmented input communicators*	have auditory language processing difficulties indicating support of verbal input through gesture or visual symbols
• *comprehensive communicators*	Avail themselves of a range of preserved skills to facilitation communication (e.g., pointing, gestures, limited letters / speech …)

III. AAC INTRODUCTION / USE

- **Assess** device's communicative capabilities against client's communicative needs
- **Assess** device's operational demands against client's motor, sensory and cognitive capabilities
- **Adapt** device's communicative contents to client's communicative situation, support
- **Train** client and family in access, use, and adaptation of communicative materials
- **Monitor** use, noting improvements often occur in natural language production with device use
- **Extend** available materials, adapt for newly possible communicative situations - turn improvements to client advantage

IV. CLINICAL RESULTS

- Approximately 40% of Lingraphica users with chronic global aphasia evolved to severe Broca's aphasia ($8 \leq AQ < 32$, mean $\Delta AQ = +5.5$).
- Some also improved in communicator type.

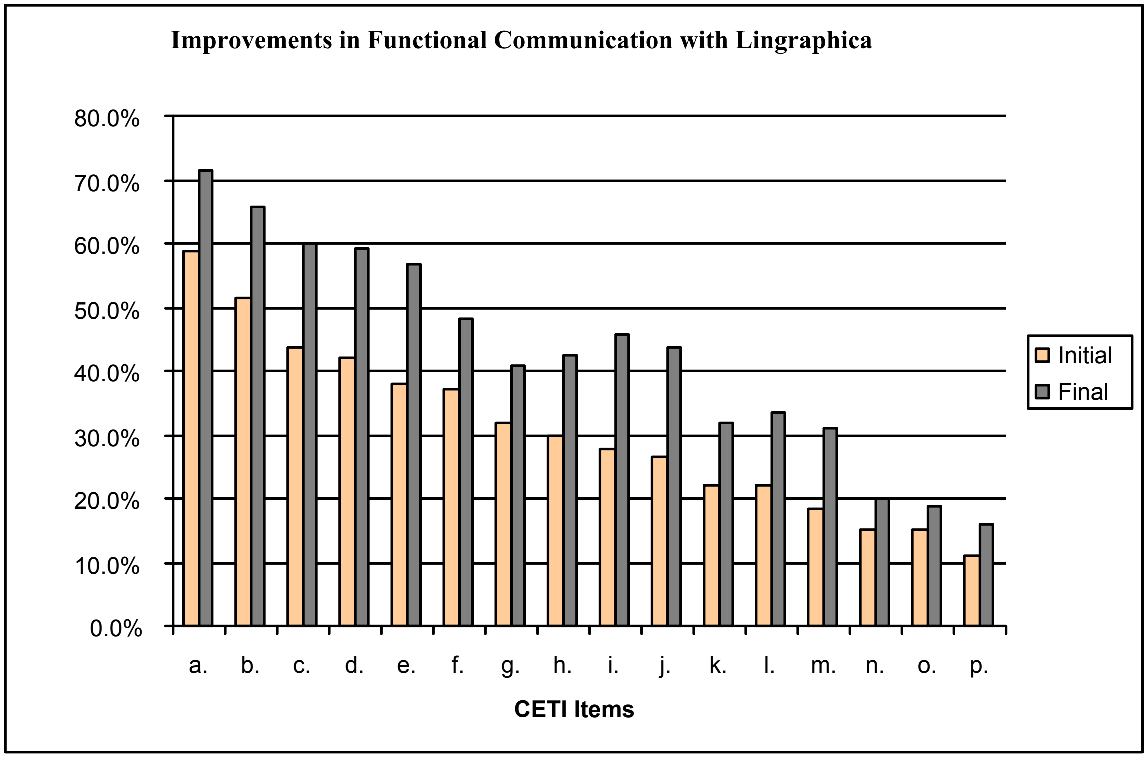

Figure Key:		CETI Item #
a.	Getting somebody's attention.	1
b.	Indicating understanding of what is being said to him/her.	5
c.	Responding or communicating without words.	11
d.	Communicating emotions.	4
e.	Communicating physical problems such as aches, pains.	9
f.	Giving yes and no answers appropriately.	3
g.	Understanding writing.	13
h.	Having coffee-time visits with friends, neighbors.	6
i.	Getting involved in group talks about self.	2
j.	Having a one-to-one conversation with you.	7
k.	Starting a conversation with people not in family.	12
l.	Having a spontaneous conversation.	10
m.	Saying the name of person in front of him/her.	8
n.	Participating in a fast group conversation.	14
o.	Participating in a conversation with strangers.	15
p.	Describing or discussing something in depth.	16

References

Brookshire, 1997
Garrett, 1992
Lomas, 1989
Kertesz, 1982
Weintich, 1995

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B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

OUTCOME IMPROVEMENTS IN PERSONS WITH CHRONIC GLOBAL APHASIA FOLLOWING THE USE OF A SPEECH-GENERATING DEVICE

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SUMMARY

Background Advanced computer-based interventions have demonstrated effectiveness in aphasia rehabilitation even in the chronic stage, and outcome studies using standardised assessment instruments reveal previously unstudied patterns of improvement and associated improvement magnitudes. Here we analyze persons with chronic global aphasia.

Material/Methods: Twenty subjects were assessed at intake and at discharge, at the impairment and functional communication levels, using standardized assessment instruments. During intervention, the subjects used a speech-generating device, therapeutically and communicatively, in the clinic and at home. Matched t-tests were used to measure the significance of overall improvements after intervention; and WAB assignments to same or different aphasia diagnostic category at discharge established subject subgroups, with one-way ANOVA employed to measure the significance of differences.

Results: Mean subject time post-onset was 2.7 years, and mean duration of intervention was 20.6 weeks. Following intervention, the subject means improved significantly on 3 of 5 impairment-level items, and on 15 of 17 functional-level items. Eight of the 20 subjects (40%) were recategorized to Broca's aphasia at discharge, while the others significantly improved within global aphasia. Overall, the Gl:Br subgroup scored significantly higher – among other items – in Auditory Verbal Comprehension, and at discharge in "having a spontaneous conversation". By contrast, the Gl:Gl subgroup improved much more during intervention than the Gl:Br subgroup in "getting someone's attention" and "communicating anything (including 'yes' or 'no') without words".

Conclusions: Advanced computer-based interventions can improve mean rehabilitation outcomes in chronic global aphasia at the impairment and functional communication levels. Some may be reassigned to Broca's aphasia, while others improve greatly in basic functional communication tasks that improve quality of life.

Key words: Severe Brain Injury Rehabilitation, Computerized Treatment

INTRODUCTION

Towards the end of his landmark study of the aphasias in wounded Soviet soldiers following WW II, Alexander Luria devotes several pages to a simple iconographic system for aphasia rehabilitation (Luria 1947). He reports benefits – including improved grammaticality and extended phrase length – in persons with expressive aphasia following use of this system. Though the improvements were modest, Luria's report is nonetheless significant. It first suggested, over six decades ago, that the use of augmentative and alternative communication (AAC) tools, materials, and methods can result in improvements in the natural speech-language communication of persons with aphasia.

Subsequently and independently, a team headed by Gardner and Zurif at the Boston Aphasia Research Center probed the use of an iconographic AAC system to support and expand communicative transactions in global aphasia. Test subjects treated with the low-technology Visual Communication (ViC) system showed modest but distinct communicative benefits, and the researchers concluded that – even in global aphasia – key linguistic capabilities may remain intact and potentially available for further rehabilitative exploitation (Gardner et al. 1976). Their research thus further advanced our understanding of AAC and aphasia, while also opening new areas for exploration.

When affordable personal computers with graphic user interfaces became available in the 1980s, the US Department of Veterans Affairs, though its Rehabilitation Research and Development Service, funded work to research the potential of implementing a visual communication system in this new medium for the rehabilitation of persons with aphasia. Initially, studies focused on replicating ViC research to establish that persons with aphasia could learn to operate the systems and use them to improve communication in tasks such as following commands, answering simple questions, and expressing basic emotions (Steele et al. 1987; Weinrich et al. 1989a; Weinrich et al. 1989b; Steele et al. 1989). Subsequently, attention shifted to identifying and analyzing new application areas for the evolving technologies (Weinrich & Steele 1988; Steele et al. 1992; Steele 1995).

Over the past decade and a half, researchers have devoted increasing energies to understanding the uses and quantifying the benefits of computer-based AAC systems employing graphic user interfaces in persons with aphasia (Dean 1987; Enderby 1987; Crerar et al. 1996; Katz 2001; Katz 2008). Various devices, including commercially offered devices by Lingraphica®, Dynavox®, and others, have been investigated by researchers in a variety of settings, including community-based clinical treatment programs and academic research settings (Aftonomos et al. 1997; Katz & Brown 2004; Koul et al. 2005; Koul & Corwin 2003; Corwin & Koul 2003; Koul & Harding 1998; Steele et al. 2003). The interest and activity has only grown since 2001, when Medicare and other insurers in the United States began reimbursing for the provision of speech-generating devices (SGDs) prescribed for use by individuals with aphasia.

At the same time, medical and aphasia rehabilitation researchers in academic and clinical settings continue developing new ways of using the standardized assessment instruments, refining methodologies for conducting research, and broadening our understanding of responses to therapy in a variety of aphasia types and severities (Ellwood 1988; Nicholas et al. 1993; Basso et al. 1996; Connolly et al. 1999; Carlomagno et al. 2001; Ansaldo et al. 2004; Sarno et al. 2005; Bakheit et al. 2005; Nolfe et al. 2006; Laska et al. 2007).

All these various and wide-ranging research efforts have contributed to progress, both individually and synergistically. In retrospect, we can see that the rehabilitation benefits from the marriage of iconographic AAC approaches with advanced computer technology have significantly exceeded initial expectations, which for various reasons were modest. For example, it has been positively confirmed that practice and use of computer-based iconographic AAC systems can produce improvements in the natural speech-language communication of persons with aphasia (Weinrich et al. 1995); research is delineating the improvement profiles – following SGD use – that are characteristic of persons in the various diagnostic categories of aphasia (Aftonomos et al. 1997; Aftonomos et al. 1999; Aftonomos et al. 2001); and outcome studies suggest that these improvements overall are age-independent (Steele et al. 2003).

Despite progress to date, however, research in these areas is still at an early stage. Much needs to be done to establish scopes, mean magnitudes, and ranges of improvements for persons in each of the various aphasia diagnostic categories. This needs to be done, moreover, at each of the three WHO disease classification levels individually, i.e., [1] impairment, [2] participation restriction (affecting functional communication), and [3] activity limitation (affecting role assumption and quality of life) (WHO 1980; WHO 2001). It is furthermore desirable to employ data from standardized, valid and reliable assessment instruments in this initiative. There is an opportunity to identify significantly different patterns of improvement within individual aphasia diagnostic categories at intake, to document the changes characteristic of each, and to describe how individuals within those patterns present clinically both at intake and discharge. Detailed analysis of these types and extent are likely to produce findings of both theoretical and practical clinical significance.

The current article represents a step in this undertaking. Here we analyze data from individuals with chronic global aphasia at intake, who became proficient with and used a commercially available icon-based SGD for one to several months, and who were assessed at intake and discharge using one or more standardized assessment instruments developed for persons with aphasia. We characterize these subjects demographically and clinically, quantitatively analyze their changes on each administered item of each assessment instrument, inspect rank orderings of functional communication items before and after use, and then compare and contrast the changes of the sample by subgroups, based on their discharge assignments to aphasia diagnostic categories. It is hoped that the results will prove of value to clinicians who work with persons in chronic aphasia, as well as to researchers who are looking to refine research questions and experimental hypotheses in studying the rehabilitation of persons in chronic aphasia.

METHOD

Subjects

The subjects were adults who had been diagnosed with aphasia and referred to community-based speech therapy programs. Additional criteria for inclusion in this study were: (i) assignment to the diagnostic category of global aphasia through intake administration of the Western Aphasia Battery (WAB, Kertesz 1982); (ii) aphasia chronicity, defined as program enrollment occurring more than 6 months post-onset for each patient; and (iii) administration – at intake and discharge – of both the WAB for speech-language impairment assessment and the Communicative Effectiveness Index or CETI (Lomas et al. 1989) for functional communication assessment. Altogether, 20 patients met the criteria, and they comprise the sample for this study. Table 1 characterizes the study subjects individually.

Table 1. Subjects

Patient	Etiology	Categ.	Gender	Age	YPO	Tx wks	Tx freq	WAB	CETI
1-MG	L-CVA	global	m	63	3.6	14.1	—	X	X
2-BJ	L-CVA	global	m	67	6.6	13.0	—	X	X
3-ER	L-CVA	global	m	71	2.4	20.4	2.9	X	X
4-AN	L-CVA	global	m	44	1.0	10.4	2.2	X	X
5-BT	L-CVA	global	m	73	6.7	21.7	2.2	X	X
6-MK	L-CVA	global	f	70	2.3	27.7	1.9	X	X
7-JM	L-CVA	global	f	63	1.5	15.0	1.9	X	X
8-WD	L-CVA	global	m	68	1.0	26.1	2.1	X	X
9-LW	L-CVA	global	m	64	1.9	22.1	1.7	X	X
10-RJ	L-CVA	global	m	45	3.8	12.4	0.8	X	X
11-DA	L-CVA	global	f	79	1.9	16.3	2.2	X	X
12-HS	L-CVA	global	m	68	1.3	21.3	1.6	X	X
13-JC	L-CVA	global	m	73	0.8	26.4	2.2	X	X
14-JM	L-CVA	global	f	68	9.0	25.0	1.8	X	X
15-MW	L-CVA	global	f	76	0.5	15.4	2.5	X	X
16-WG	L-CVA	global	m	60	0.7	21.4	1.6	X	X
17-RP	L-CVA	global	m	68	4.3	16.9	2.0	X	X
18-JC	L-CVA	global	f	73	1.3	23.0	3.0	X	X
19-CC	L-CVA	global	f	66	0.7	45.9	1.1	X	X
20-MC	L-CVA	global	f	85	3.0	18.3	2.5	X	X

Table 2. Summary of Demographic / Clinical Data

Characteristic	Mean (SD)	Range	No. (%)
Gender			
male			12 (60.0)
female			8 (40.0)
Age (y)	67.2 (9.7)	44–55	20 (100)
Handedness			
right			9 (45.0)
unknown			11 (55.0)
Time post-onset (y)	2.70 (2.35)	0.52–8.97	20 (100)
Etiology			
L–CVA			20 (100)
Intake assessments			
WAB AQ	13.4 (5.2)	4.4–25.3	20 (100)
CETI Overall	30.8 (13.3)	7.6–61.9	20 (100)
Treatment			
frequency (sess/wk)	2.0 (0.5)	0.8 – 3.0	20 (100)
duration (wks)	20.6 (7.8)	10.4–45.9	20 (100)
Intake/Discharge Assessments			
impairment level (WAB)			20 (100)
functional level (CETI)			20 (100)

All subjects participated in clinical treatment programs that operated under the supervision of designated Medical Directors to provide speech-therapy services for reimbursement by Medicare and/or other insurance. In accordance with hospital and clinic policies under which these programs operated and with Medicare regulations under which reimbursement was obtained, informed consent was obtained from all subjects. None of the sites acquired imaging data on the subjects. Table 2 provides a summary overview of subjects' demographic and clinical data.

Treatment

All subjects used the Lingraphica® Speech Generating Device (SGD) in the clinic and at home (Aftonomos et al. 1997). In the clinic, they participated twice a week in 1-hour, one-on-one therapy sessions with Speech-Language Pathologists (SLP), who trained the subjects in the use of programmed therapy exercises, and used a formal treatment algorithm to guide decisions regarding exercise types, difficulty levels, and activity progressions. The subjects took their SGDs home and had unrestricted access for assigned "homework," exploration of domains, word repetition, communication composition, practice, rehearsal, and the support of interactive communication with others.

Subject participation continued as long as improvement in natural speech communication could be documented; after that, the subjects were discharged.

Assessment

The subjects were assessed at intake and discharge using the language subtests of the WAB and the 16 items of the CETI. Both are standardized, valid and reliable assessment instruments providing quantitative scores at complementary levels of the WHO taxonomy of illness: the WAB assessing the impairment level, and the CETI assessing functional communication. Administrations were done in the standard ways, without the SGD present, in order to assess natural, unaided speech-language communication. The WAB was administered by the treating Speech-Language Pathologist in the clinic, and the CETI ratings were completed by someone close to the subject – most often a spouse or other family member, occasionally a unrelated caregiver – who was familiar with the communicative style of the subject before the onset of aphasia. The resulting scores comprise valid, reliable quantitative data on 22 assessed items (WAB – 5, CETI – 17), from a sample of 20 subjects, at both intake and discharge.

Data Analysis

Raw data were entered into the Data Desk® application for statistical and exploratory data analysis (James 1998; Tukey 1977). We first investigated within-subject changes, to compare the performance of individuals before and after program participation. To investigate change over time, we calculated the existence, magnitude, and direction of the difference of means before and after program participation, and then established the statistical significance of those differences, using matched t-tests (Student's test). This yields a before/after comparison on each of the 5 assessed items of the WAB, and on each of the 17 assessed items of the CETI. The paired t–tests thus scrutinize 22 independent and orthogonal items: independence is clear prima facie for the items of the WAB, and it was established through factor analysis during construction of the CETI (Lomas et al. 1989). This approach yields rich outcome detail at two complementary levels, i.e., impairment and functional communication.

We then partitioned our sample into two subgroups, based on assignment to aphasia diagnostic category at discharge, and analyzed how they compared at intake, during participation, and at discharge. Thus, for each subgroup at each time, means and standard deviations were calculated, the existence, magnitude, and performance levels of subgroups calculated, and one-way analyses of variance (ANOVA) were used to calculate the statistical significance of the difference of the means.

In all cases, the level for rejection of the null hypothesis was set at $p < .05$ (Hatch & Farhady 1982).

RESULTS

Overall: At the impairment level (see Table 3), matched t-tests show that the overall sample of 20 subjects improved significantly in two of the four WAB language subtests (Auditory Verbal Comprehension, Naming) and in the computed Aphasia Quotient (AQ); the remaining two language subtests (Spontaneous Speech, Repetition) showed no significant changes. Of those items showing significant improvements, mean Auditory Verbal Comprehension scores rose from 60.7 at intake to 72.8 at discharge, an improvement of

Table 3. Impairment-level changes after SGD use

Item	n	Initial Mean (SD)	Final Mean (SD)	Diff (SD)	t_{obs}	p
Spontaneous speech	20	2.4 (1.5)	2.8 (2.0)	+ 0.4 (1.5)	+1.22	≤ .237
Auditory Verbal Comprehension	20	60.7 (12.8)	72.8 (19.4)	+12.1* (14.4)	+3.77	≤ .002
Repetition	20	9.2 (14.4)	13.8 (14.3)	+ 4.6 (11.5)	+1.82	≤ .085
Naming	20	4.2 (5.6)	7.5 (8.4)	+ 3.3* (4.6)	+3.07	≤ .007
Aphasia Quotient (AQ)	20	13.4 (5.2)	17.0 (6.1)	+ 3.6* (3.9)	+4.14	≤ .001

*$p < .05$

Table 4. Functional Communication Changes, After SGD Use

CETI Item Nº	n	Initial Mean (SD)	Final Mean (SD)	Diff (SD)	t_{obs}	p
1	20	58.8 (31.4)	71.4 (23.2)	+12.6* (20.1)	+2.79	≤ .02
2	19	30.0 (18.4)	42.6 (23.2)	+12.6* (10.2)	+5.37	≤ .001
3	20	37.8 (22.2)	56.9 (20.5)	+19.1* (11.7)	+7.33	≤ .001
4	20	42.1 (23.3)	59.1 (20.2)	+17.0* (10.3)	+7.38	≤ .001
5	20	51.4 (21.8)	65.8 (19.3)	+14.4* (15.3)	+4.22	≤ .001
6	20	37.2 (29.0)	48.0 (19.4)	+10.8* (15.7)	+3.07	≤ .01
7	20	31.8 (22.5)	41.0 (25.3)	+ 9.2* (8.3)	+4.99	≤ .001
8	20	18.2 (21.2)	31.1 (23.1)	+12.9 (28.2)	+2.04	= .055
9	20	26.5 (18.4)	43.6 (20.7)	+17.1* (17.4)	+4.39	≤ .001
10	20	22.1 (21.8)	33.5 (24.1)	+11.4* (13.8)	+3.71	≤ .01
11	20	43.7 (30.4)	60.7 (24.7)	+16.5* (22.3)	+3.32	≤ .01
12	20	22.2 (25.7)	31.8 (25.8)	+ 9.6* (12.2)	+3.51	≤ .01
13	19	27.7 (26.6)	45.8 (31.8)	+18.1* (17.2)	+4.58	≤ .001
14	19	15.1 (15.1)	18.6 (20.4)	+ 3.5 (11.3)	+1.36	= .19
15	20	15.3 (20.1)	20.1 (20.3)	+ 4.8* (6.8)	+3.15	≤ .01
16	20	11.1 (13.4)	15.9 (15.1)	+ 4.8* (5.7)	+3.74	≤ .01
1–16 Overall	20	30.8 (13.3)	42.8 (14.4)	+12.0* (7.3)	+7.39	≤ .0001

*$p < .05$

+12.1% (p < .002); mean Naming scores increased from 4.2 at intake to 7.5 at discharge, an improvement of +3.3% (p < .007); and mean AQ scores went from 13.4 at intake to 17.0 at discharge, an improvement of +3.6% (p < .001). Quantitatively, all these improvements are of modest magnitude.

At the functional communication level (see Table 4), matched t-tests show that the overall sample of 20 subjects improved significantly in fourteen of the sixteen CETI items rated, as well as in the means of Items 1-16 Overall. Only (i) Item 8 ("Saying the name of someone whose face is in front of him/her") and (ii) Item 14 ("Being part of a conversation when it is fast and there are a number of people involved") showed no significant change. The magnitudes of the significant improvements ranged from + 4.8% (Items 15 & 16) to +19.1% (Item 3). Overall, the means of Items 1-16 for subjects – an indication of functional communication improvement generally in the sample – rose from 30.8 at intake to 42.8 at discharge, an improvement of +12.0% (p < .0001).

Table 5 identifies the 16 items assessed by the CETI, and gives rank orders of the subjects' mean scores for these items at intake and discharge.

Table 5. Rank Orders of CETI Items Before/After SGD Use

Rank Orders at:		
Intake	Discharge	CETI Item (number & verbatim phrasing)
1	1	# 1. Getting somebody's attention
2	2	# 5. Indicating that he/she understands what is being said to him/her
3	3	#11. Responding to or communicating anything (including *yes* or *no*) without words
4	4	# 4. Communicating his/her emotions
5	5	# 3. Giving *yes* and *no* answers appropriately
6	6	# 6. Having coffee-time visits and conversations with friends and neighbors (around the bedside or at home)
7	10	# 7. Having a one-to-one conversation with you.
8	9	# 2. Getting involved in groups conversations that are about him/her
9	7	#13. Understanding writing
10	8	# 9. Communicating physical problems such as aches and pains
11	12	#12. Starting a conversation with people who are not close family
12	11	#10. Having a spontaneous conversation (*i.e.,* starting the conversation and/or changing the subject)
13	13	# 8. Saying the name of someone whose face is in front of him/her
14	14	#15. Participating in a conversation with strangers
15	15	#14. Being part of a conversation when it is fast and there are a number of people involved
16	16	#16. Describing or discussing something in depth

'Before ~ After' Spearman Rank Order Correlation Coefficient: $\rho = .9853$

Towards the top of the table are the items with higher numerical ratings, signaling greater communicative success; and towards the bottom are the more challenging items, with lower numerical ratings. At page bottom, we report the calculated Spearman Rank Order Correlation Coefficient for the intake and discharge orderings – $\rho = .9853$ – indicative of high overall stability of ordering.

By Discharge Groups: The WAB assigns subjects to aphasia diagnostic categories based on the values and patterns of subject scores on their individual language subjects. One criterion for inclusion in this study was WAB assignment at intake to the diagnostic category of global aphasia. Readministration of the WAB to all subjects at discharge showed that 12 of the 20 subjects (60%) continued in the category of global aphasia, while the remaining 8 subjects (40%) were reassigned to the less severe diagnostic category of Broca's aphasia. Using these discharge assignments, we partitioned the overall sample into two subgroups: [i] those whose discharge assignment remained global aphasia (i.e., the Gl:Gl group); and [ii] those whose discharge assignment changed to Broca's aphasia (i.e., the Gl:Br group). Mean scores for each of these subgroups can be computed separately, compared, and tested for statistical significance using analyses of variance (ANOVA). This approach reveals whether the group means differ significantly: (i) at intake; (ii) in improvement, during program participation; and (iii) at discharge.

At the impairment level: At intake (Table 6), one-way ANOVAs of raw data show that WAB mean scores for the Gl:Br group are significantly higher than mean scores for the Gl:Gl group on two language subtests: namely, Auditory Verbal Comprehension and Naming. The mean Auditory Verbal Comprehension score of the Gl:Gl group at intake was 55.2, while that for the Gl:Br group at intake was 68.9. The difference of 13.7, in favor of the Gl:Br group, is significant at the $p = .014$ level. The mean Naming score for the Gl:Gl group at intake was 1.9, while that for the Gl:Br group was 7.5 – a significant difference of 6.6 ($p = .026$), again favoring the Gl:Br group.

At discharge (Table 6), the impairment-level picture resembles the intake picture, with the Gl:Br group scoring significantly higher in the mean than the Gl:Gl group on Auditory Verbal Comprehension and Naming; but now the mean differences by group are yet greater than at intake, as are also the associated p values. Of particular note, at discharge the Gl:Br group outscored the Gl:Gl group in Auditory Verbal Comprehension by 31.7 points, and the means are very widely separated ($F = 36.50$, $p << .0001$). Over the same period, Gl:Br's advantage in Naming has risen to 8.9 points ($p = .016$).

One-way ANOVA of improvements during program participation (Table 6) shows that the Gl:Br group improved significantly more than the Gl:Gl group on one language subtest, namely, Auditory Verbal Comprehension. The Gl:Gl group improved their mean scores by +4.9, while the Gl:Br group improved theirs by +22.9; the difference of +18.0* – favoring the Gl:Br group – is significant at the $p = .003$ level.

Table 6. Impairment-level ANOVAs: Global:Global (12) vs. Global:Broca's (8)

WAB Item	Gl:Gl Means	Gl:Br Means	Diff	*F*-ratio	p
Intake Assessments					
Spontaneous Speech	2.5	2.1	(0.4)	0.31	= .588
Auditory Verbal Comprehension	55.2	68.9	13.7*	7.41	= .014
Repetition	8.3	10.5	2.2	0.11	= .742
Naming	1.9	7.5	5.6*	5.92	= .026
AQ	12.6	14.7	2.1	0.84	= .372
Improvements (Δ) during Participation					
Spontaneous Speech	+0.5	+ 0.2	(0.3)	0.13	= .719
Auditory Verbal Comprehension	+4.9	+22.9	18.0*	11.70	= .003
Repetition	+2.3	+ 8.1	5.8	1.24	= .280
Naming	+2.0	+ 5.3	3.3	2.36	= .142
AQ	+2.3	+ 5.5	3.2	3.45	= .080
Discharge Assessments					
Spontaneous Speech	3.0	2.3	(0.7)	0.43	= .519
Auditory Verbal Comprehension	60.1	91.8	31.7*	36.50	<< .0001
Repetition	10.6	18.6	8.0	1.56	= .229
Naming	3.9	12.8	8.9*	7.08	= .016
AQ	14.9	20.2	5.3	4.26	= .054

$^*p < .05$

In functional communication: At intake (Table 7), one-way ANOVA on CETI data shows that mean scores for the Gl:Br group are significantly higher than for the Gl:Gl group on three items, namely #1 ("Getting somebody's attention"), #7 ("Having a one-to-one conversation with you"), and #11 ("Responding to or communicating anything [including yes or no] without words"). Differences on the 13 remaining items are non-significant.

By discharge (Table 7), the Gl:Br group scored significantly higher than the Gl:Gl group on two CETI items, namely #7 ("Having a one-to-one conversation with you") and #10 ("Having a spontaneous conversation [i.e., starting the conversation and/or changing the subject]"). While they continue to score higher on two other items – #1 and #11 – their advantages on these are no longer significant, as they were at intake. For these latter two items, then – as on all remaining items – differences in group means at discharge are not significant.

Table 7. Functional Communication ANOVAs: Global:Global(12) vs. Global:Broca's (8)

CETI Item Nº	Gl:Gl Means	Gl:Br Means	Diff	*F*-ratio	p
Intake Assessments					
1 - re: getting attention	46.3	77.6	31.3*	6.07	= .024
2 - re: group conv. about self	26.3	36.3	10.0	1.31	= .268
3 - re: answering yes/no	33.9	43.6	9.7	0.91	= .352
4 - re: commun. emotions	36.7	50.3	13.6	1.69	= .210
5 - re: indicating understanding	47.3	57.4	10.1	1.02	= .325
6 - re: coffee-time visits	30.5	47.3	16.8	1.66	= .215
7 - re: one-to-one conv.	23.1	44.9	21.8*	5.57	= .030
8 - re: saying person's name	19.8	15.6	-4.2	0.18	= .676
9 - re: comm. phys. problems	23.8	30.8	7.0	0.69	= .418
10 - re: spontaneous conv.	19.3	26.3	7.0	0.48	= .497
11 - re: responding w/o words	30.5	63.4	32.9*	7.53	= .013
12 - re: starting conversations	20.5	24.8	4.3	0.13	= .727
13 - re: understanding writing	29.8	24.3	-5.5	0.18	= .678
14 - re: fast conv., many people	15.4	14.6	-0.8	0.01	= .920
15 - re: conv. with strangers	14.8	16.0	1.2	0.02	= .903
16 - re: in-depth discussions	12.0	9.8	-2.2	0.13	= .724
1–16 Overall	26.9	36.3	9.4	2.78	= .113
Improvements (Δ) during Participation					
1 - re: getting attention	+18.0	+ 4.3	(13.7)	2.44	= .136
2 - re: group conv. about self	+10.4	+16.4	6.0	1.63	= .219
3 - re: answering yes/no	+20.4	+17.2	-3.2	0.37	= .551
4 - re: commun. emotions	+18.3	+15.0	-3.3	0.49	= .494
5 - re: indicating understanding	+15.2	+13.4	-1.8	0.06	= .805
6 - re: coffee-time visits	+13.2	+ 7.2	-6.0	0.67	= .424
7 - re: one-to-one conv.	+ 8.1	+10.9	2.8	0.54	= .473
8 - re: saying person's name	+10.3	+16.9	6.6	0.25	= .621
9 - re: comm. phys. problems	+17.5	+16.3	-1.2	0.02	= .892
10 - re: spontaneous conv.	+ 5.4	+20.3	14.9*	7.66	= .013
11 - re: responding w/o words	+26.0	+ 2.2	(23.8)*	7.29	= .015
12 - re: starting conversations	+ 5.9	+15.0	9.1	2.95	= .103
13 - re: understanding writing	+18.8	+16.8	-2.0	0.05	= .817
14 - re: fast conv., many people	+ 2.6	+ 4.8	2.2	0.15	= .699
15 - re: conv. with strangers	+ 5.5	+ 3.8	-1.7	0.31	= .587
16 - re: in-depth discussions	+ 6.8	+ 1.8	-5.0	4.02	= .060
1–16 Overall	+12.8	+11.3	-1.5	0.27	= .610

One-way ANOVA of improvements during program participation (Table 7) shows that each group has one item of significantly greater improvement than the other. The Gl:Br group improved significantly more than the Gl:Gl group on #10 ("Having a spontaneous conversation [i.e., starting the conversation and/or changing the subject]"). In contrast, the Gl:Gl group improves significantly more than the Gl:Br group on #11 ("Responding to or communicating anything [including yes or no] without words").

Table 7 cont. Functional Communication ANOVAs: Global:Global(12) vs. Global:Broca's (8)

Discharge Assessments					
1 - re: getting attention	64.3	81.9	17.6	3.03	= .099
2 - re: group conv. about self	36.7	52.7	16.0	2.27	= .150
3 - re: answering yes/no	54.3	60.8	6.5	0.46	= .508
4 - re: commun. emotions	55.0	65.3	10.3	1.26	= .277
5 - re: indicating understanding	62.5	70.8	8.3	0.87	= .362
6 - re: coffee-time visits	43.7	54.5	10.8	0.72	= .407
7 - re: one-to-one conv.	31.2	55.8	24.6*	5.62	= .029
8 - re: saying person's name	30.1	32.5	2.4	0.05	= .826
9 - re: comm. phys. problems	41.3	47.1	5.8	0.39	= .539
10 - re: spontaneous conv.	24.7	46.6	21.9*	4.77	= .042
11 - re: responding w/o words	56.5	65.6	9.1	0.64	= .433
12 - re: starting conversations	26.4	39.8	13.4	1.30	= .269
13 - re: understanding writing	48.6	41.1	-7.5	0.24	= .631
14 - re: fast conv., many people	18.0	19.4	1.4	0.02	= .889
15 - re: conv. with strangers	20.3	19.8	-0.5	0.01	= .952
16 - re: in-depth discussions	18.8	11.6	-7.2	0.95	= .342
1–16 Overall	39.7	47.6	7.9	1.49	= .237

*$p < .05$

Group Relationships, Categorized: Table 8 extracts from Tables 5 and 6 those items where significant differences between the Gl:Gl group (n = 12) and the Gl:Br (n = 8) group are documented at one or more points in time, and organizes the findings to highlight endpoint relationships. Three patterns were found: [i] the Gl:Gl group starts at a significant disadvantage with respect to the Gl:Br group, but overcomes that disadvantage over the period of the study; [ii] the Gl:Br group starts with significant advantages over the Gl:Gl group, and holds those advantages stable over the course of the study; and [iii] the Gl:Br group improves in ways and at magnitudes that confer upon it qualitatively new advantages over the Gl:Gl group by the time of discharge.

Inspection shows that – at the impairment level – the two WAB items showing significant group differences (i.e., Auditory Verbal Comprehension, Naming) both favor the Gl:Br group. In contrast, at the functional communication level, there is some balance: in two CETI items (#1, #11), the Gl:Gl group holds the advantage, catching up with the Gl:Br group by discharge and ending up not significantly worse; while in two other CETI items (#7, #10), the Gl:Br group is the favored one, starting out and/or ending up significantly better than the Gl:Gl group.

DISCUSSION

The current findings extend and refine results reported in earlier studies, and open new territory by describing differential improvement patterns by discharge diagnoses that have not previously been closely investigated.

Table 8. Subgroup ANOVA endpoint relationships, categorized

Gl:Gl Group Catches Up with Gl:Br Group		
at Intake	Gl:Gl Δ Advantage	at Discharge
CETI #1 – Getting somebody's attention		
Gl:Gl significantly worse (p = .024)	13.7 ns	Gl:Gl not significantly worse ns
CETI #11 – Responding to or communicating anything (including yes and no) without words		
Gl:Gl significantly worse (p = .013)	23.8* (p = .015)	Gl:Gl not significantly worse ns
Gl:Br Group Holds On to Initial Significant Advantage		
at Intake	Gl:Br Δ Advantage	at Discharge
WAB – *Naming*		
Gl:Br significantly better (p = .026)	3.3 ns	Gl:Br significantly better (p = .016)
CETI #7 – Having a one-to-one conversation with you		
Gl:Br significantly better (p = .030)	2.8 ns	Gl:Br significantly better (p = .029)
Gl:Br Group Improves Qualitatively, via Significant Quantitative Improvements		
at Intake	Gl:Br Δ Advantage	at Discharge
WAB – Auditory Verbal Comprehension		
Gl:Br significantly better (p = .014)	18.0* (p = .003)	Gl:Br vastly better (p << .0001)
CETI #10 – Having a spontaneous conversation (i.e., starting the conversation and/or changing the subject		
Gl:Br not significantly better ns	14.9* (p = .013)	Gl:Br significantly better (p = .042)

This study corroborates earlier findings that persons in the chronic stage of global aphasia may well be candidates for further statistically significant improvements following SGD therapy and use, at both the impairment and functional communication levels. Generally, improvements at the impairment level are modest in magnitude (e.g. single-digit percentages), while improvements in functional communication may be sizable (e.g. double-digit percentages). Regardless of magnitude, however, these improvements can be important practically. For persons with global aphasia, who start from a low base, these gains may represent important steps, contributing out of proportion to their limited magnitude to more effective communication and improved quality of life.

Earlier studies had reported significant impairment-level improvements for persons with chronic global aphasia, and that a sizable minority of persons with chronic global aphasia move to Broca's aphasia following SGD use (Aftonomos et al. 1999), but these reports were confined to the WAB AQ, an overall measure of involvement (Aftonomos et al. 1999; Aftonomos et al. 2001). The current study extends the analysis of this phenomenon, by using data from both the impairment and functional communication levels in comparing the two groups, Gl:Gl and Gl:Br. We report each of the sixteen rated items of the CETI individually, in addition to the overall improvement previously reported.

At the impairment level, data analysis corroborates the received clinical wisdom that chronic global aphasia is refractory, difficult to remediate. Scores on two of the four language subtests (50%) were low at intake and showed no significant improvement by discharge. The overall measure of involvement – the WAB AQ – showed an improvement that, while statistically significant ($p < .001$), is of modest clinical importance at best, registering a mean only in the low single digits (+3.6*).

At the functional communication level, improvements are larger and more consistent. Of the sixteen CETI items rated, fourteen (87.5%) showed improvements that were statistically significant ($p \leq .02$), of which ten (62.5%) were double-digit in magnitude (11.4–19.1). The findings establish that persons with chronic global aphasia may be candidates for widespread noteworthy improvements in functional communication, even in the face of severe, stubborn impairment-level deficits. They also suggest that metalinguistic factors, such as attention, focus, motivation and communicative environment, can play key roles, given the mostly static language assessments during the course of treatment. The question of just which non-linguistic factors are contributing, how, and why, thus emerges as an issue for future research.

Most strikingly, at the impairment level, the Gl:Br group significantly outperforms the Gl:Gl group in Auditory Verbal Comprehension at intake, in improvement, and at discharge, and the advantage grows larger with time. At intake, the Gl:Br group's raw AVC score is 25% larger than the Gl:Gl group's; by discharge, the advantage is 50% larger. It is surprising to find this change among persons in the chronic stage of global aphasia; it is surprising to find it affecting such a large minority (40%) of these cases; and it is very surprising to find over 35 standard deviations separating the means of the two groups by discharge. Clearly in some individuals with global aphasia, AVC holds unrealized potential for substantial improvement; and initial AVC scores may help identify these persons. Future controlled experimental research designs may help us build on this knowledge, to develop clinical tools to improve treatment goal formulation, prognoses, and intervention selection and application.

Perhaps equally important is the finding that not all quantitatively large changes favor the Gl:Br group. On two quite basic items of functional communication – namely, CETI #1: 'Getting somebody's attention', and CETI #11: 'Responding to or communicating anything (including yes or no) without words' – the Gl:Gl group improved during treatment much more than does the Gl:Br group. As a result, by time of discharge the initial significant advantage of the Gl:Br group over the Gl:Gl group is removed. In effect, persons in the Gl:Gl group improve sufficiently to become – by discharge – indistinguishable in these tasks from persons who evolve to Broca's aphasia. This is no small thing, either clinically or functionally: in persons with global aphasia, such changes can contribute in key ways to success in everyday communicative transactions, improving satisfaction and helping to raise quality of life.

Several considerations influenced the selection of data analysis techniques employed in this study. The first consideration was directness: matched t-tests are the simplest and most direct method permitting establishment of magnitude and significance of a sample's change over time, item by item; and one-way ANOVA is analogously the first-order way of comparing and contrasting changes in those assessed items, subgroup by subgroup. Where assessed items are all orthogonal – a prima facie property of the WAB items, and a constructed property of the CETI items – the large number of tests is not a problem per se, and the results comprise a picture of broad and rich detail. A second consideration was maintenance of comparability with previously reported analyses. Earlier publications had employed these statistical tests, but had focused primarily on analyzing data from summary measures, e.g., the WAB AQ, the CETI Overall. The present report supports both direct comparison with previously published analyses, and examination of important details behind those summary results. And finally, a third consideration was to avoid introducing Type II errors by utilizing techniques that overly fragment the initial sample of 20. Partitioning that sample into Gl:Gl and Gl:Br produces subgroups of 12 and 8 respectively, on the edge of acceptability. Further partitioning – say, for examining interaction effects – seems ill advised until sample size is increased.

An important caveat regarding generalization of findings requires mention. The subjects whose data are reported and analyzed here do not constitute a randomly selected sample of persons with chronic global aphasia. Rather, this was a self-selected group of persons in chronic aphasia that chose to participate in a treatment program employing an advanced treatment technology. They are likely not representative generally of persons with chronic global aphasia, in at least two respects: (i) they presumably subjectively felt they were capable of further improvement at time of intake; and (ii) they were not dissuaded by the introduction of an unfamiliar technology. These considerations do not negate the validity or importance of findings reported here, but they do prompt the question of how widespread such outcomes would be among all persons with chronic global aphasia. This is a question that only future research can answer.

We note in addition that the current findings emerge from an outcome study, which is a variety of post-hoc analysis. An inherent limitation of outcome studies is that they do not allow for the attribution of causality – whether to SGD features, to length of use sessions, to engagement in particular activities, or to any other factors. Attribution of causality requires controlled, experimental research designs. Nonetheless, as Ellwood importantly noted in his 1988 Shattuck Lecture (Ellwood 1988), through well conceived, executed and reported outcome studies clinical practitioners may make significant contributions to medical science, in two ways. First, quantitatively superior clinical outcomes may help identify and refine best practices for everyday clinical service delivery; and second, emergent findings in outcome studies may help shape the formulation of questions and selection of the investigative methodologies employed in subsequent controlled, experimental research designs (Ellwood 1988).

CONCLUSIONS

As it stands, this outcome study provides some valuable new insights into the types and magnitudes of improvements that may be found in persons with chronic global aphasia following treatment with an SGD. It corroborates the hypothesis that global aphasia is typically refractory at the impairment level, but that functional communication is often amenable to changes of importance in quality of life. It shows that some persons in chronic global aphasia may improve enough to evolve to severe Broca's aphasia, and that even those who do not nonetheless can improve greatly in basic functional communication. It helps identify issues that may merit future controlled, experimental research, and it suggests fruitful directions for work to improve clinical tools, materials, and methods. Considering that chronic global aphasia is often viewed as unpromising for clinical intervention, the current findings suggest new grounds for engagement and hope.

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Evaluation and Treatment of Aphasia Among the Elderly With Stroke

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While aphasia is not per se a geriatric disorder, risk factors for aphasia increase with age, and effective treatments for older individuals must be sensitive to age-related needs and circumstances. This article first reviews evaluation tools, with their assessment domains and ways of using them, then moves to treatment approaches, with an eye in particular to describing experiences using advanced treatment programs with older aphasic patients, and concludes with discussions and examples of outcomes analyses that contribute to our understanding of improvements following treatment in older patients. **Key words:** *advanced treatment programs, aphasia rehabilitation, computers, outcomes*

THE DEFINITION of aphasia is a topic of discussion to this day.[1] In a 1996 review article, Holland et al defined aphasia as "a language disorder that occurs in adults following focal brain damage, typically involving the language-dominant cerebral hemisphere."[2] They go on to say that while aphasia can occur in children, it is primarily a disorder of older persons—one that limits patients' abilities to communicate with others through speech, sign, reading, and writing. They note its often devastating impact on the lives of persons who are—prior to onset—typically fully competent communicators. Theirs is a characterization of aphasia that will readily be recognized by clinicians who work with aphasic individuals, as it concisely captures the observable features of the disorder. Traditional names identify the most common aphasic syndromes. Global aphasia, for instance, is the label applied to severe impairments in all modalities without exception—speaking, speech comprehension, reading, and writing. Broca's aphasia is characterized by halting, effortful, and telegraphic utterances with relative preservation of verbal comprehension. Wernicke's aphasia combines fluency of speech-like production with lack of communicative content—eg, via malapropisms, nonsense neologisms, syntactic incoherence, etc—and also with severe comprehension deficits. Conduction aphasia affects verbal expression foremost, in particular the ability to repeat spoken words or phrases. Persons with anomic aphasia contend most observably with a truncated active vocabulary, often searching unsuccessfully for a word or resorting to descriptive paraphrase.

While aphasic disorders after stroke are not limited to older persons, the risks for such aphasias do increase with age. The primary cause of aphasia in the United States currently is stroke, and over one third of all stroke hospital admissions present with symptoms of aphasia.[3] An aging US population, increasing

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rates of stroke survival, and greater life expectancies among those who survive stroke all combine to suggest that both the incidence and the prevalence of geriatric aphasias will rise in America's future.

Age may interact with lesion size and location after stroke to influence aphasia type. Both ischemic and hemorrhagic events may produce aphasic syndromes, but examples of similar lesions resulting in dissimilar aphasia types in older and younger patients have been reported.[4–7] Nonfluent aphasias appear to be more prevalent than fluent aphasias generally among geriatric persons, and when encountered, the fluent aphasias are more likely to co-occur with anterior lesions in older patients compared to younger ones.[8]

Age may negatively influence the extent of spontaneous neurologic recovery in aphasic patients. Pashek and Holland[8] found that patients under the age of 70 were twice as likely to show complete or partial recovery compared to patients over 70 one year postonset. The presence of dementia will also have an impact on presentation and response to therapy in this group, and complicates measures both of spontaneous recovery and improvement after treatment. Up to one quarter of all geriatric patients with global aphasia have been reported as being demented.[8]

A clear distinction, nonetheless, must be made between deleterious effects of age on spontaneous recovery on the one hand, and treatment outcomes in response to therapy among geriatric patients on the other. Older patients judged to be appropriate candidates for speech–language therapy by generally accepted criteria may be expected to perform as well as younger cohorts. Advanced age in itself is not a predictor of poor functional rehabilitation outcomes; as shown below and elsewhere, treatment outcomes following appropriately prescribed therapy appear in fact to be independent of age.[9,10]

In developing treatment strategies for geriatric persons with aphasia, consideration must be given to the age-appropriateness and acceptability of the tools, materials, and methods involved, and patients may vary considerably in preferences. The development of advanced treatment technologies in recent years in general extends the range of therapy options available to speech–language therapists working with geriatric patients. Specific accommodations may be required to meet the special needs of geriatric patients, who as a rule will be in their declining years of physical, sensory, and cognitive powers. But absent specific contraindications, older as well as younger persons with aphasia appear well positioned to benefit from properly structured and executed therapeutic regimens that employ contemporary advanced technologies.

Bearing all this in mind, below we offer the discussion of the evaluation and treatment of aphasia after stroke for those who work with older persons. Under the major sections below, we discuss each topic area from 2 complementary perspectives—first, providing an overview of issues and items of importance to the topic generally, and second, presenting concrete examples that draw on the authors' first-hand experiences over the past several years providing adult outpatient aphasia therapy through a network of advanced community-based treatment programs known specifically as Language Care Center® (LCC) Treatment Programs.[11–16] This dual approach, we believe, provides readers both with useful overview of main clinical issues, as well as with discussion of practical considerations associated with everyday service delivery.

For completeness, we conclude this introductory section with a brief overview of other, noninfarct related conditions that are also encountered among older individuals and that may affect speech, language, and/or communication in ways similar to aphasic syndromes. Alzheimer and non-Alzheimer dementias, for example, may be associated with language deficits, subordinate to the cognitive impairments or as a principal feature. In general, however, these neurodegenerative processes represent a spectrum where language disturbances play typically a less prominent role relative to the disruption of overall cognitive function and the associated behavioral disorders.

In 1892, Pick[17] described a case of language disturbance associated with left posterior frontal and temporal atrophy. Since then, the term Pick's disease has been widely applied to similar progressive degenerative diseases with characteristic associated behavioral disturbances.

Frontotemporal dementia (FTD) is the currently preferred term for describing focal frontal and temporal cortical atrophy. Hodges[18] describes a classification of the principal variants of FTD including frontal variant FTD, semantic dementia, and progressive nonfluent aphasia. These non-Alzheimer dementias are associated with variable degrees and types of behavioral and language disturbances, from overgeneralized stereotypical speech patterns to more traditional aphasia symptoms such as dysnomia, paraphasia, or prosodic impairments.

The term Primary Progressive Aphasia (PPA) has been applied to a group of fluent and nonfluent dementia-related aphasias.[19] The PPA syndrome, with a typical onset in the 55–65-year age group, is characterized primarily by a gradual decline in language function as the predominant characteristic with relative preservation of memory, visuospatial functioning, and personality. The typical presentation consists initially of word-finding impairments that slowly progress to involve the syntactic and then the semantic components of language. This is distinguished from the communicative disturbances of Alzheimer's disease and frontal lobe dementia, in which word-finding difficulties and paucity of speech appear later in the course of the disease, and are secondary to the more severe and pervasive memory and behavioral deficits.

Of relevance to treatment and outcome, the progressive language impairments in these syndromes may be related not only to linguistic deficits, but also to malfunctions in nonlanguage systems. Patients with semantic dementia may present with a fluent aphasia characterized by loss of memory for words. Warrington has suggested that such progressive anomic deficits may reflect a fundamental loss of semantic memory.[20] In contrast, patients presenting with PPA perform well on tests of semantic memory.[21]

EVALUATION OF APHASIA

The clinical assessment of aphasia can involve complete or partial use of standardized instruments, such as the Boston Diagnostic Assessment Examination (BDAE) or the Western Aphasia Battery (WAB).[22,23] Documented validity and reliability of such standardized tests make their use psychometrically attractive. Alternatively, clinical assessments may employ ad hoc tasks or informal procedures devised by examining clinicians or others; with this approach, validity and reliability are uncertain. A hybrid approach intersperses various ad hoc tasks with selected items extracted from existing instruments.

Levels of assessment

Assessments of aphasia—either formal or informal—address various levels of performance and stratify patients by impairment and functional levels. The most widely-known scheme for describing the impact of sickness (eg, stroke) on the lives of individuals is that originally introduced by the World Health Organization (WHO) in 1980 and recently revised; it identifies 3 distinct levels: (i) the *impairment* level; (ii) the *participation restriction* (or *functional*) level; and (iii) the *activity limitation* level.[24] Characterized briefly, *impairment* refers to loss or abnormality in organic function or structure; *participation restriction* refers to impairment-induced diminution in capacity to carry out tasks functionally; and *activity limitation* refers to the socially negative consequences of impairments or participation restrictions. Further information and order forms for WHO's recently revised instrument, now called the International Classification of Functioning, Disability, and Health (ICF), may be found at www3.who.int/icf/icftemplate.cfm.

Given access to both necessary assessment instruments and requisite time, clinicians could in theory assess each patient at each of the 3 levels, capturing a multidimensional snapshot of patient status at each point of assessment. In practice, this is uncommon. Instead, impairment-level data are most widely used, as they are relatively easily gathered by the therapist via testing in the clinic. In contrast, it can be comparatively difficult for therapists to validly and reliably assess activity limitation or participation restriction as patients go through the routines of their lives outside the clinic, where clinicians frequently have little or no access.

Assessment instruments

A recent book chapter surveys assessment instruments and assigns each to a subcategory below each WHO level.[25] Instruments at the impairment level fall into 4 subtypes: (1) standardized aphasia test batteries; (2) supplementary tests for aphasic impairments; (3) controlled probe tasks; and (4) discourse sampling. The first subtype—standardized aphasia test batteries—includes 4 items worth listing individually, given the relative thoroughness with which they assess patients' performance at the impairment level: (i) Aphasia Diagnostic Profiles[26]; (ii) BDAE[22]; (iii) Porch Index of Communicative Ability(PICA)[27]; and (iv) WAB.[23] The 4 instruments in this list are likely to be familiar, at least generally, to most clinicians. Assessment instruments in the aforementioned categories (2)–(4) are useful in tracking narrower areas of performance (eg, the Boston Naming Test for assessing confrontational naming performance),[28] but that very narrowness makes them better suited to uses in more closely-targeted research studies than in community-based clinical treatment programs with their wider range of patient types, severities, and treatment goals.

At the level of functional communication (WHO "activity limitation"), 3 instrument subtypes are identified: (1) general rehabilitation measures; (2) measures of functional communication—rating scales; and (3) direct assessment of functional communication. Seven items in the latter 2 categories are worth naming here. Rating scales for assessing functional communication include (i) the Functional Communication Profile[29]; (ii) the Communicative Effectiveness Index(CETI)[30]; (iii) Revised Edinburgh Functional Communication Profile[31]; (iv) the Communication Profile[32]; and (v) ASHA Functional Assessment of Communication Skills for Adults.[33] Direct assessment of functional communication characterizes (i) Communicative Abilities in Daily Living[34] and (ii) the Amsterdam–Nijmegen Everyday Language Test.[35]

At the WHO "participation restriction" level, assessment instruments are assigned to 1 of 3 types: (i) psychosocial measure/depression scales; (ii) health-related quality of life measures; and (iii) measures of well-being. While these instruments do probe aspects of handicap, none focuses on participation restrictions that are occasioned by impairments or activity limitations that are specifically communicative in nature. Indeed, there is an unmet need at the participation restriction level for an assessment instrument with a communicative focus.

Assessment considerations

In addition to validity and reliability, there are several other properties that are desirable in assessment instruments to be used in clinical settings. These include sensitivity to change (responsiveness), relevance of assessed items to rehabilitation purposes, and practicality of administration. Instruments vary considerably along these parameters, depending on their authors' goals during development. Sometimes the properties work at cross-purposes: for example, PICA achieves exquisite sensitivity to change,[27] but administrators must go through a special training and certification course to become proficient in using its 16-level performance scoring scale; it can also be time-consuming to administer, and—without computer assistance—tedious to score, which may compromise its practicality for daily clinical application (as opposed to research uses).

Also, if *outcomes* are to be analyzed and reported, then consistency and completeness in clinical data gathering are obligatory. It is useful to identify explicitly all portions of an assessment instrument to be administered, and to gather those data completely. It is also necessary to this end to gather data at 2 points in time, so that change over the interval can be established. For purposes of documenting treatment outcomes specifically, recommended times are at Start of Care (when the patient undergoes initial evaluation), and at Discharge (when course of treatment has been completed).

In past decades, aphasiology researchers have relatively infrequently investigated treatment outcomes per se. Rather, they have focused primarily on treatment efficacy, which may be roughly defined as changes after treatment under ideal conditions (delineated etiologies, clear patient syndromes, minimal medical complications, rigorously observed treatment frequencies and durations, high compliance levels). Outcome analyses, in contrast, document changes after treatment under real-world clinical conditions (mixed etiologies, differing patient types, possible intercurrent medical complications, varying treatment frequencies and durations, inconsistent compliance).[36] The distinction is important, as a treatment of demonstrated efficacy may—or may not—lead to significantly improved outcomes in the real world, depending on the magnitude and robustness of treatment effects, caseload mixes, levels of patient compliance, and other factors. The only way to know for sure whether outcomes are significantly improved after clinical treatment is to track and analyze outcomes directly.

Clinical use of assessment instruments: illustrative example

For assessment at the impairment level, clinicians in LCC Treatment Programs are encouraged to use the language subtests of WAB, which clearly distinguish between aphasic and nonaphasic language.[23] WAB contains an algorithm for calculating an overall metric of aphasia severity known as the Aphasia Quotient (AQ), and it also assigns aphasic patients to 1 of 8 diagnostic categories (eg, global aphasia, Broca's aphasia, Wernicke's aphasia, anomic aphasia, etc). The 6 language subtests of WAB (Spontaneous Speech, Auditory Verbal Comprehension, Repetition, Naming, Reading, Writing) probe modalities individually, and administration can usually be accommodated within an initial 90-minute evaluation session.

For assessment of functional communication, LCC Programs use CETI.[30] CETI was designed to focus on functional tasks of particular importance to persons with aphasia, to be quick and easy to complete, to be sensitive to change, and to be filled out by a family member or significant other who is able to observe the patient frequently as the latter engages in communicative activities of daily living in the community. From a conceptual perspective, it is noteworthy that the functional ratings of the family member serve to complement the impairment-level test scores of the treating clinician. This approach provides 2 independent yet related views on patient status, and coherently interpretable results at the 2 levels may boost confidence in emergent findings.

TREATMENT OF APHASIA

Conceptually, speech therapy for the rehabilitation of adults with aphasia draws on a similar range of approaches as its principal neighbors in rehabilitation medicine, namely physical therapy and occupational therapy. When treating patients, rehabilitation specialists including speech pathologists aim if possible for *restoration* of function through therapeutic interventions, and where restoration is beyond reach, treating clinicians may draw on *educative* techniques and/or *compensatory* strategies to enhance functional performance.

In constituting courses of treatment for patients, speech pathologists may organize therapy regimens in accordance with various alternative conceptual frameworks. There are, for example, neurolinguistic approaches that focus on the treatment of underlying linguistic forms; there are neuropsychological approaches addressing cognitive impairments

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in the comprehension and production of words; and there are more traditional therapy approaches relying on language stimulation to promote the functional reintegration of underlying cerebral mechanisms. Chapey's anthology[37] provides an excellent introduction to the available spectrum. Some speech pathologists are strong adherents of one conceptual framework, while others are more eclectic and draw on this or that approach as adjudged to be of likely benefit to patients. It is probably fair to say that each approach has proved capable of delivering measurable benefits to appropriate patients, and none of them has consistently outperformed all others in magnitude of benefits across patients generally.

Complicating matters, therapists must also take into account numerous additional factors beyond speech–language deficits when deciding how to proceed therapeutically. They also have to consider, for example, a patient's goals, personality, psychological state, therapy setting, living and family situations, rehabilitation support, treatment duration authorization, and reimbursement levels, among others. In view of all this, it is not surprising to read Damasio's observation that "[t]here is no standard treatment of aphasia."[38] Rather, speech pathologists will make best judgments on what practicable therapy approaches are likely to benefit a patient most, given the range of constraints under which they and the patient will be operating.

Traditional therapy approaches are the most widely used. Schuell's "stimulation approach" to rehabilitation, treated in the first chapter under "Traditional Approaches" in Chapey's anthology, provides a good example.[39] Hers is an approach that has proved fruitful over time, being adapted and extended by clinicians using new tools and materials as they have become available. Schuell viewed language as the dynamic result of complexly choreographed interactions of activities occurring throughout the brain. Neither the activities nor the various resulting modalities of language can be neatly isolated: in her view, competent language performance is "of a piece." Schuell's observation that language *performance* appears to be more impaired than language *competence* in cases of aphasia led her to believe that important opportunities exist for the reintegration of performance components through appropriate stimulation of the patient. The resultant performance improvements reflect not so much the *reteaching* of language as the successful reintegration of the underlying components of competent language use. Her conceptual approach also led to clear and practical recommendations on how therapy should be conducted. For example, intensive auditory stimulation should be used; it should be controllable, along various dimensions (volume, duration, predictability of timing, inclusion of other modalities); it should be repeatable, and at the patient's instance; stimuli should elicit a response; inadequate responses may require not so much correction as repeated or enhanced stimulation; there should be systematic work from relatively simpler to relatively more challenging materials; and activities should build upon one another in a coherent, integrative fashion. Schuell and colleagues additionally developed a classification system of aphasia reflective of her understanding of the nature of the disorder and opportunities for patient improvement through the stimulation approach.

Despite the variety and heterogeneity of different treatment approaches, aphasia interventions are of demonstrated efficacy. This has been shown in randomized, controlled studies, as well as through literature reviews and meta-analyses.[2,40–42] One of the earlier, largest, most rigorously designed, and highly regarded studies, the 1986 VA Cooperative Study under the clinical leadership of Wertz, documents both the efficacy, and reflects the heterogeneity in treatment approaches.[40] Treatment for all patients was described as "individual" though usually of a "stimulus–response" variety; it focused on performance in areas ranging from "auditory comprehension" to "writing"; it variously involved picture identification, verbal repetition, and sentence completion; and at selected sites it adhered to the treatment guidelines of formally specified programs such as Melodic Intonation Therapy,[43] or PACE.[44] As to technology, treating clinicians in this study drew on the traditional varieties, ie, paper, pencil, pictures, word lists, etc.

Recent years have witnessed additional striking improvements in outcomes following treatment of aphasia. As a rule, these improvements are associated with the incorporation of additional technologies into the treatment process. While some of these are of the high-technology variety, others are organizational/operational in nature, and yet others relate to the analysis and reporting of clinical outcomes.[13] Below we discuss some of the issues faced by clinicians trying to understand and cope with such recent developments.

High-technology treatment tools

These are usually computer-like clinical devices, or treatment software for general-purpose computers, sometimes with associated print materials. Many examples may be found at the website www.mankato.msus.edu/dept/comdis/kuster2/ For 2 decades, researchers have been reporting benefits to patients from the use of such tools.[11,45–48] Benefits cited variously include more consistent stimuli, self-paced practice, automatic results reporting, greater clinician productivity, and improved performance following treatment. Such tools clearly may confer benefits.

Such benefits come at a cost, however. Usually, there are both direct and indirect costs to be borne. Software packages, for example, require that the clinician purchase or lease a computer system, and if a patient is to practice at home, then either the patient must acquire the system or the clinician must provide it. Furthermore, hardware and software require upgrading periodically. There are time commitments required to learn to operate systems and programs, and further attention will likely be required to individualize treatment for each patient. These are not inconsequential considerations.

There is the further matter of cost-effectiveness. In the current context of fiscal restraints and ever increasing emphases on clinician productivity, it is not adequate simply to get better results. Costs should not thereby increase, or—even better—they should decrease. For all these reasons, the penetration of high technology into the realms of clinical speech therapy has generally been slow and uneven. A practical problem here is that one crucial piece of information has typically been lacking, namely, what improvements following treatment are actually documented in clinical practice for patients using a particular approach. Outcome studies have begun to address this issue.[49]

Integrated programs with advanced tools: illustrative example

As a concrete example, LCC Treatment Programs incorporate 4 key components that have been designed to work in concert to constitute effective courses of therapy. These 4 components are (a) a *Patient Care Algorithm*, which provides detailed treatment guidelines for each of the diagnostic categories of aphasia and related disorders; (b) a *Data Registry* for recording demographic, diagnostic, treatment, and assessment data of patients treated; (c) a proprietary treatment technology known as the *Lingraphica® (LG) System*, which is used both during treatment sessions in the clinic and also at home between treatment sessions for patient practice of prescribed clinical exercises[50,51]; and (d) specialized *Training* for treating clinicians in the use of these various LCC tools, materials, and associated methods. For aphasic patients in need of a Speech Generating Device following discharge from treatment, a prosthetic version of the LG System is also available.

Clinicians who provide therapy in this way are encouraged to gather data before and after courses of treatment—using WAB for patient assessment at the impairment level, and CETI for patient assessment by family members at the functional communication level—and to submit the scores for entry into a centralized data registry. Data aggregation has been underway for several years, and data are now available on many hundreds of patients.

Outcome analyses using these data establish that persons with aphasia improve significantly, in the mean, in every measure tracked following participation in such courses of treatment. Targeted examples follow below.

Results documentation: quantitative

Performance changes after treatment

The most straightforward thing to do with outcomes data is to calculate whether, in the mean, the performance of a sample of patients has improved significantly after treatment on some assessed item. A recent analysis of data from 50 participants in 2 LCC Treatment Programs showed these persons with aphasia improved significantly after treatment—in the mean—in every language modality assessed at the impairment level by WAB (ie, spontaneous speech, auditory verbal comprehension, repetition, naming, reading, writing) and on WAB's overall metric of severity, AQ, as well as on all 16 functional communication items included on CETI.[14] Mean AQ improvement for the sample was found to be +10.5 points (+10.5%), with a mean CETI overall improvement of +18.2 points (+18.2%). This sample included 34 patients who were more than 6 months postonset at start of LCC care, and 42 who had been discharged from more traditional speech therapy previously.

Table 1 illustrates how outcome analyses can help better understand the relationship of age to improvements after treatment. Here, a sample of 282 LCC patients of all ages is divided into age ranges by decades, with WAB AQ means before and after treatment calculated and compared by groups. Analysis shows that the mean AQ score improves in every age range, and that those improvements are significant ($p < .05$) for every group in which $n \geq 6$. Visual inspection of the improvement data suggests an overall general pattern of diminution in the improvement scores with increasing age, and a one-way analysis of variance reveals a trend toward significance ($p = .07$) in improvement magnitudes by age ranges. The results document that—while patients in all age ranges may be candidates for significant improvements at the impairment level after treatment in LCC programs—the magnitudes of these improvements may possibly decline slightly with increasing age. This latter issue appears deserving of further study.

Results documentation: qualitative

In addition to quantitatively calculating mean score improvements using assessment instrument scores (as illustrated above), one can also examine outcome data to identify important patterns of qualitative change. Previous analyses have documented a significant pattern of evolution to less severe aphasia

Table 1. Quantitative outcome examples—WAB AQ improvements following LCC treatment, by age at start of care ($n = 282$)

Age at start of care	*n*	Pre-treatment mean	Post-treatment mean	Difference of means	*p*
$20 \leq$ Age < 30	4	55.3	68.6	+13.3	>.1
$30 \leq$ Age < 40	6	39.2	55.5	+16.3*	.01
$40 \leq$ Age < 50	14	49.3	59.5	+10.2*	<.0001
$50 \leq$ Age < 60	46	52.9	66.3	+13.4*	<.0001
$60 \leq$ Age < 70	81	39.1	48.2	+9.1*	<.0001
$70 \leq$ Age < 80	85	50.4	58.5	+8.1*	<.0001
$80 \leq$ Age < 90	43	54.3	61.5	+7.2*	<.001
$90 \leq$ Age < 100	3	58.7	70.5	+11.8	>.2

*$p < .05$.

Table 2. Qualitative outcome examples—changes in aphasia diagnostic categories following LCC treatment, in chronically aphasic patients 75 years and older (n = 79)

	Post-Tx Dx						Within normal limits
	Global	Broca's	Wernicke's	Transcortical motor	Conduction	Anomic	
Pre-Tx Dx							
Global (7)	*5*	**1**	**1**				
Broca's (25)		*17*	**2**	**1**	**5**		
Wernicke's (7)	**2**		*4*		**1**		
Transcortical motor (2)						**2**	
Conduction (10)					*8*	**1**	**1**
Anomic (28)			**1**			*23*	4

Categories are ordered by ascending midpoints of AQ-ranges; numbers in the table indicate patient counts by diagnostic categories; italics indicate same-type aphasia diagnostic categories before and after LCC treatment; boldface indicates different type of aphasia diagnostic categories accompanied by an AQ change—up or down—of at least 5.0 points.

diagnostic categories in chronic aphasia following participation in LCC Treatment Programs.[12] Table 2 presents the findings of such an analysis using data specifically from a sample of older patients. In this instance, the patient sample comprises 79 individuals over 75 years of age, all of whom were more than 6 months postonset at start of LCC care and hence were in the presumed chronic stage of aphasia. Table 2 compares patients' WAB assignments to aphasia diagnostic categories before and after LCC treatment specifically for patients whose WAB AQ score changed—up or down—by at least 5.0 points following treatment. Results show that—among these 79 chronically aphasic older patients—19 (24%) were reassigned to a less severe aphasia diagnostic category following LCC treatment, while 3 patients (4%) were reassigned to a more severe diagnostic category. In the previous report, which included both younger and older aphasic patients, the overall pattern was rather similar: 17 of 46 subjects (37%) evolved to less severe diagnostic categories, while 0 of 46 (0%) evolved to more severe diagnostic categories. This general comparability suggests that whatever mechanisms underlie these particular changes may be available to many older patients as well as to younger ones.

Speech generating devices in aphasia rehabilitation

Finally, some older (as well as younger) adults with aphasia benefit from having a speech generating device (SGD) to help meet their communication needs in everyday life following discharge from speech therapy. Such prosthetic aids properly represent yet another element in the arsenal of tools available for aphasia rehabilitation, and beginning in 2001, Medicare began covering the provision of such SGDs to appropriate patients with aphasia and related disorders. In a recent chapter entitled "Computer applications in aphasia treatment," Katz[52] gives a more complete list of available options, with brief device descriptions and effectiveness discussions.

CONCLUSIONS

The conclusions that follow appear warranted on the basis of available evidence: First, ways of evaluating aphasia, treating patients, and documenting outcomes that are well conceived and executed for persons with aphasia in general appear to hold their worth in dealing with aphasia among geriatric patients as well. There appears, in particular, to be no blanket contraindication to the use of appropriately designed advanced treatment technologies or programs per se with older persons. There further appear to be no intrinsic obstacles to the introduction of advanced treatment programs into various settings. Significantly improved outcomes appear to be available to appropriately identified candidates at all age levels. Outcome analyses of data presented here suggest the possibility of a gradual and slight diminution of treatment effect sizes, absolutely, with increasing age. Qualitatively, however, older patients appear to move to less severe diagnostic categories in numbers and following patterns similar to those documented for younger persons with aphasia also, at least following LCC treatment. Finally, SGDs may play an important role for ongoing communication support of older persons with aphasia. In general, then, the treatment of geriatric aphasia is shown to be first and foremost the treatment of *aphasia*, though leavened with a heightened awareness of, and responsiveness to, age-related issues.

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Relationships between impairment-level assessments and functional-level assessments in aphasia: Findings from LCC treatment programmes

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We report an outcome study of persons with aphasia participating in community-based treatment programmes. Patients ($n = 50$) were assessed before and after treatment using: (i) a standardised test of *impairment*, the *Western Aphasia Battery*, administered by treating clinicians; and (ii) a standardised assessment of *disability* (functional communication), the *Communicative Effectiveness Index*, rated by family members. Pretreatment and post-treatment means are calculated and compared, with matched *t*-tests utilised to probe statistical significance of improvements after treatment. We then calculate impairment- and functional-level means by aphasia diagnostic categories, assigning rank orders and calculating Spearman rank-order correlations. Data analysis shows that, before treatment, patients spanned a wide range of times after onset, aphasia diagnostic types, and severity levels at start of care. Following treatment, means of the 50 patients improved significantly on every measure administered at both the impairment and the functional levels. Absolute improvements ranged from 6.5% to 26.2%, with statistical significance ranging from $p < .01$ to $p << .0001$. Before treatment, there is strong positive correlation ($\rho = +.90$) between impairment-level and functional-level assessment means by diagnostic categories; after treatment, improvement means by these diagnostic categories show moderate negative correlation ($\rho = -.60$). Further examination shows that post-treatment improvements are found to be best viewed as functions of same-type severity levels pretreatment, with patterns of improvement at the impairment and functional levels diverging distinctly.

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In a retrospective seminar at ASHA's 1999 Annual Convention, entitled *A Hundred Years' Worth of Aphasia Treatment* and featuring Robert T. Wertz, Leonard L. LaPointe, and Audrey L. Holland as presenters and Nancy Helm-Estabrooks as moderator, the speakers observed that specialists in aphasia presently know all too little about relationships between impairment-level performance and disability-level (or functional) performance in persons with aphasia. All agreed that, for reasons of both theory and clinical practice, it has become increasingly important to improve our understanding of these relationships. Earlier work has shown this to be no trivial task; for one thing, as Sarno observed over a decade and a half ago "It should be clear that standard aphasia tests cannot be used to assess functional recovery" (Sarno, 1984, p. 218). Incorporating data from a functional assessment instrument developed since then, the authors offer this further investigation of these issues, raised so recently anew by leaders in the field.

Since 1995, the authors have been involved with outpatient treatment programmes that routinely assess patients at the impairment and functional levels, before and after treatment, with standardised instruments that generate quantitative data. Using these data, we present here an outcome study that examines improvements after treatment from a sample of 50 persons with aphasia, all of whom received care through these specialised, community-based treatment programmes. We first analyse changes after treatment at the impairment level and the functional level individually, and then probe relationships between the assessment scores at these two levels, before and after participating in the treatment programmes.

METHOD

Treatment programmes

Patients were treated in two community-based treatment programmes specially developed to provide consistent, structured courses of therapy to adults with aphasia and related disorders. These programmes, which provide services for reimbursement, are known as Language Care Center℠ (LCC) Treatment Programmes and are more fully described elsewhere (Harris, Shireman, & Steele, 1997; Harris, Aftonomos, & Steele, 2000). They are in general distinguished by the skilled use of four specially developed components. These are: [i] a *Patient Care Algorithm* for indicating clinical treatment pathways; [ii] a custom *Database* for capturing patient demographic, diagnostic, treatment, and performance assessment data; [iii] a portable, proprietary, stimulating, adult-appropriate, computer-based treatment technology known as the *Lingraphica*® *System* which is used by patients and therapists jointly in clinical sessions, and by patients independently at home (Steele, 1995); and, [iv] specialised *Training and Support* of licensed, certified speech-language pathologists to assure mastery of LCC tools, materials, and methods.

Briefly, service delivery in LCC Treatment Programmes proceeds as follows. In each clinical session, the treating speech-language pathologist refers to the Patient Care Algorithm's *Treatment Guidelines* that are provided for each aphasia diagnostic category. These guidelines suggest appropriate materials for patient use from the Toolbox—an extensive collection of prepared clinical exercises readily loaded on the Lingraphica System for use. Where suggested materials are found to be helpful, the clinician may further individualise them to better match the patient's goals, abilities, and challenges; the clinician then supports the patient in learning and practising their use. At the end of each treatment session, the clinician stores the individualised and rehearsed exercises in a special folder on the patient's Lingraphica System, for the patient's access and use at home. The Lingraphica System automatically records its own use in the background, and past analyses of such records show that patients practise, on average, over 2 hours per day with such materials when participating in these treatment programmes (Aftonomos, Steele, & Wertz, 1997).

Patients

Data reported here are from two LCC programmes in Palo Alto (PA), California and Kansas City (KC), Kansas respectively, both comparably trained, equipped, and supported in provision of therapy services throughout their data collection periods. Patients were drawn from individuals referred to either of the LCC sites and diagnosed with aphasia. The referrals for treatment in these programmes came from physicians, hospitals, other community-based programmes, speech-language pathologists, friends, family, and self-referral. To qualify for inclusion in this study, subjects had to meet four criteria: [i] assignment to one of the eight aphasia diagnostic categories via intake administration of the *Western Aphasia Battery* (WAB, Kertesz, 1982); [ii] completion of at least 1 month of therapy in the LCC treatment programme; [iii] pretreatment and post-treatment receipt of all language subtests from the WAB; and [iv] pretreatment and post-treatment ratings on all 16 items on the *Communicative Effectiveness Index* (CETI, Lomas et al., 1989). The first 50 patients from the LCC programmes to meet these criteria chronologically comprise the study subjects.

Detailed demographic and clinical characteristics of the patient sample are displayed in Table 1, with data summaries given in Table 2. Of the 50 patients, 49 (98%) had become aphasic from left cerebral hemisphere infarcts; the other patient became aphasic from traumatic brain injury. Of the 50 patients, 34 (68%) were more than 6 months postonset, putting them into the presumed chronic stage of aphasia; 33 (66%) of the patients were treated at the PA site, the remaining 17 (34%) at the KC site. For 42 (84%) of the 50 patients, LCC treatment followed discharge previously from one or more courses of speech therapy elsewhere; the remaining eight patients (16%) were referred for LCC treatment as their first course of speech-language therapy.

Treatment

Patients participated in therapy with their treating clinicians in individual, 50-minute sessions. Table 1 characterises frequency and duration for patients individually, with Table 2 summarising these data. Overall, mean number of treatment sessions per patient was 37.8 (SD 20.4, range 9–99). In clinical sessions, therapists typically employed stimulus–response strategies based on sequences of therapeutic activities suggested by the Patient Care Algorithm which, through experience, we have found to be of benefit. At home, patients completed prescribed clinical exercises and were also free to pursue other materials and activities of their own choosing. Patients were discharged when, in the opinion of treating clinicians, gains in functional communication levelled off. In this—as elsewhere generally—LCC practice is to adhere to Medicare guidelines, as Medicare patients comprise the bulk of caseloads within LCC Treatment Programmes.

Assessment

For documentation of *impairment*-level performances, the WAB was administered pretreatment and post-treatment by patients' treating clinicians. Besides assessing speech-language impairment by modality, the WAB assigns patients to one of eight aphasia diagnostic categories, and produces an overall quantitative metric of aphasic

TABLE 1
Subjects ($n = 50$)

Patient	Aetiology	Diagnostic category/severity	Gender	Age	Years post-onset	Weeks of therapy	Tx freq.: Sess./Wk	Tests: WAB	Tests: CETI
01 RC	L-CVA	anomic/mild	m	67	0.98	27.3	1.43	X	X
02 RC2	L-CVA	anomic/mild	f	70	0.36	12.4	1.77	X	X
03 DD	L-CVA	anomic/mild	f	79	0.07	9.6	2.92	X	X
04 RK	L-CVA	anomic/mild	m	81	0.08	8.0	2.88	X	X
05 JL	L-CVA	anomic/mild	m	85	0.07	4.1	3.41	X	X
06 HN	L-CVA	anomic/mild	f	61	0.04	4.4	2.05	X	X
07 GR	L-CVA	anomic/mild	f	77	1.96	20.0	2.20	X	X
08 CE	L-CVA	anomic/mod.	m	82	0.20	19.6	2.19	X	X
09 PC	L-CVA	Broca's/sev.	f	66	1.16	31.3	1.60	X	X
10 JD	L-CVA	Broca's/sev.	m	61	0.58	14.0	2.21	X	X
11 MF	L-CVA	Broca's/sev.	f	71	1.42	32.1	1.81	X	X
12 LN	L-CVA	Broca's/sev.	f	81	1.64	29.3	2.80	X	X
13 GN	L-CVA	Broca's/sev.	f	66	1.72	29.4	2.59	X	X
14 JT	L-CVA	Broca's/sev.	m	73	6.60	20.4	1.76	X	X
15 CB	L-CVA	Broca's/sev.	m	66	3.18	5.1	3.92	X	X
16 CG	L-CVA	Broca's/sev.	m	61	3.16	26.6	1.80	X	X
17 SA	TBI	Broca's/mod.-sev.	f	24	2.55	46.7	1.69	X	X
18 HA	L-CVA	Broca's/mod.-sev.	m	73	0.56	5.1	2.35	X	X
19 LC	L-CVA	Broca's/mod.-sev.	f	63	0.16	12.3	2.68	X	X
20 GY	L-CVA	Broca's/mod.-sev.	m	60	3.85	20.9	1.72	X	X
21 CM	L-CVA	Broca's/mod.-sev.	m	65	0.64	13.1	1.45	X	X
22 MB	L-CVA	Broca's/mod.	f	81	7.19	6.0	2.83	X	X
23 TK	L-CVA	Broca's/mod.	m	73	0.98	10.3	2.52	X	X
24 FL	L-CVA	Broca's/mod.	m	84	0.02	13.4	2.69	X	X
25 MR	L-CVA	Broca's/mod.	f	74	0.63	32.4	3.06	X	X
26 EC	L-CVA	Broca's/mod.	f	71	1.51	15.4	1.62	X	X
27 DL	L-CVA	Broca's/mod.	f	55	1.71	17.1	0.99	X	X
28 JS	L-CVA	Broca's/mod.	f	61	3.37	13.0	1.62	X	X
29 VS	L-CVA	Broca's/mod.	f	67	0.63	14.0	1.79	X	X
30 DD	L-CVA	conduction/mod.-sev.	f	70	0.39	16.1	3.04	X	X
31 LB	L-CVA	conduction/mod.-sev.	f	76	12.02	26.6	1.35	X	X
32 JD	L-CVA	conduction/mod.	f	69	4.09	7.7	1.82	X	X
33 WW	L-CVA	conduction/mod.	m	67	6.13	20.1	1.99	X	X
34 JE	L-CVA	conduction/mod.-mild	f	83	4.01	22.1	1.09	X	X
35 CH	L-CVA	conduction/mild	f	44	0.49	17.1	2.75	X	X
36 JC	L-CVA	global/sev.	f	73	1.25	23.1	2.94	X	X
37 WD	L-CVA	global/sev.	m	54	0.26	15.6	1.86	X	X
38 DB	L-CVA	global/sev.	f	65	1.19	24.3	2.02	X	X
39 MK	L-CVA	global/sev.	f	70	2.25	27.9	2.04	X	X
40 JM	L-CVA	global/sev.	f	63	1.45	15.1	1.52	X	X
41 BT	L-CVA	global/sev.	m	73	6.69	21.9	2.15	X	X
42 AH	L-CVA	transcort. mot./mod.	m	80	0.42	25.6	2.77	X	X
43 HS	L-CVA	transcort. mot./mod.	f	73	0.39	16.7	1.92	X	X
44 DK	L-CVA	transcort. sens./mod.	m	69	0.54	13.7	2.34	X	X
45 KH	L-CVA	Wernicke's/sev.	m	84	0.47	10.6	2.08	X	X
46 LJ	L-CVA	Wernicke's/sev.	f	80	0.45	18.7	1.12	X	X
47 JL	L-CVA	Wernicke's/sev.	f	83	0.72	8.9	1.91	X	X
48 RD	L-CVA	Wernicke's/mod.-sev.	m	57	0.08	18.4	2.12	X	X
49 SP	L-CVA	Wernicke's/mod.	f	67	0.83	25.6	2.70	X	X
50 JV	L-CVA	Wernicke's/mod.	m	49	0.69	25.7	1.48	X	X

TABLE 2
Demographic/clinical data summary ($n=50$)

Characteristic	*Mean (SD)*	*Range*	*No. (%)*
Gender			
male			21 (42)
female			29 (58)
Age at start of care (y)	68.9 (11.4)	24–85	50 (100)
younger, <60	47.2 (12.3)	24–57	6 (12)
older, ≥60	71.9 (7.5)	60–85	44 (88)
Time post-onset (y)	1.84 (2.37)	0.02–12.01	50 (100)
acute, <6 mo. (y)	0.24 (0.17)	0.02–0.49	16 (32)
chronic, ≥6 mo. (y)	2.58 (2.55)	0.54–12.01	34 (68)
Aetiology			
L-CVA			49 (98)
TBI			1 (2)
Aphasia type at intake			
Broca's (AQ)	35.9 (18.4)	10.0–59.9	21 (42)
anomic (AQ)	84.9 (10.1)	64.3–93.4	8 (16)
conduction (AQ)	57.7 (18.0)	35.2–82.7	6 (12)
global (AQ)	12.8 (5.9)	6.4–21.8	6 (12)
Wernicke's (AQ)	38.4 (10.0)	27.0–55.1	6 (12)
transcortical motor (AQ)	70.2 (10.5)	62.7–77.6	2 (4)
transcortical sensory (AQ)	74.9 —	—	1 (2)
Treatment			
frequency (sess/wk)	2.1 (0.6)	1.1–3.9	50 (100)
duration (wk)	18.3 (8.8)	4.1–46.7	50 (100)
Assessment			
impairment level (WAB)			50 (100)
functional level (CETI)			50 (100)

severity known as the Aphasia Quotient (AQ). The WAB has been psychometrically characterised and shown to be valid and reliable (Shewan & Kertesz, 1984). For *functional* communication assessment, the CETI was completed pretreatment and post-treatment by family members or caretakers who could observe patients communicating in their daily lives. The CETI contains 16 items of documented functional importance to persons with aphasia and their caregivers, and has been psychometrically evaluated and found to be valid and reliable (Lomas et al., 1989). All testing and rating were done in the standard ways, as published by the instruments' authors (Kertesz, 1982; Lomas et al., 1989), to assess patients' unaided, natural-language performance, in the absence of the specialised treatment technology. Scores on every item of each instrument were obtained for all 50 patients.

Statistical methods

Preliminary analyses were conducted to probe factor independence of the CETI's 16 items that assess changes in functional communication. Next, using raw WAB and CETI scores, pretreatment and post-treatment means were calculated and compared with two-tailed, paired t-tests (Hatch & Farhady, 1982). Patients' AQs and CETI Overall (1–16) means were also computed and analysed in the same matter. Throughout, level for rejection of the null hypotheses was set at $p = .05$. Statistical significance, where achieved, is indicated by an asterisk (*). Pretreatment and post-treatment AQ and CETI Overall means were then calculated by aphasia diagnostic categories at start of care, rank orders assigned, and Spearman rank-order correlations were calculated. Finally, pretreatment and post-treatment AQ and CETI Overall means were also calculated for comparison at the four quarter-ranges of same-type assessment severity.

RESULTS

Preliminary examination of data

The authors of the CETI conducted factor analysis during instrument development, to include only those items for rating that are independent factors in assessing change in functional communication between two points in time (Lomas et al., 1989). We explored the issue of degree of correlation between the 16 items for our data corpus by calculating the Pearson Product-Moment Correlation Coefficients for the 120 possible item pairwise comparisons, using the change means of the 50 patients on each item. These calculations revealed: $r_{x,y} \geq .70$ in 1 of the 120 cases (0.8%); $.60 \leq r_{x,y} < .70$ in 4 cases (3.3%); $.50 \leq r_{x,y} < .60$ in 4 cases (3.3%); and $r_{x,y}$ ranged between .49 and $-.27$ in the remaining 111 cases (92.6%). The findings indicate generally low correlation levels among items overall, consonant with factor independence.

Impairment level improvements after treatment

Patients' mean scores improved significantly following treatment on all language subtests of the WAB, as well as on the calculated AQ. Improvements expressed as absolute percentages ranged from +6.5%* to +13.0%*, with p values ranging from $p < .01$ to $p << .0001$. Table 3 presents details of improvements after treatment on each of the

TABLE 3
WAB (impairment level) improvements following treatment

WAB Item	*n*	*Pre-treatment mean (SE)*	*Post-treatment mean (SE)*	*Difference of means (SE)*	t_{obs}	*p*
Spontaneous speech	50	8.5 (0.9)	11.1 (0.9)	+2.6* (0.5)	+5.18	<0.0001
Auditory verb. comp.	50	136.8 (6.4)	150.5 (6.3)	+13.7* (2.9)	+4.67	<0.0001
Repetition	50	40.6 (4.8)	50.1 (4.8)	+9.5* (1.8)	+5.18	<0.0001
Naming	50	36.5 (4.4)	46.7 (4.7)	+10.2* (2.1)	+4.73	<0.0001
Reading	45	45.1 (3.1)	51.6 (3.1)	+6.5* (2.1)	+3.12	<0.01
Writing	31	33.5 (4.2)	43.6 (4.8)	+10.1* (2.7)	+3.74	<0.001
Aphasia quotient	50	46.0 (3.7)	56.5 (4.0)	+10.5* (1.4)	+7.53	<<0.0001
WAB AQ improvements by aphasia diagnostic category						
anomic	8	84.9 (3.6)	90.4 (4.0)	+5.5* (1.4)	+4.37	<0.01
Broca's	21	35.9 (4.0)	49.4 (5.1)	+13.5* (2.5)	+5.44	<0.0001
conduction	6	57.7 (7.5)	69.1 (7.8)	+11.4* (1.0)	+11.7	<0.001
global	6	12.8 (2.3)	19.5 (2.4)	+6.7* (1.7)	+3.95	<0.01
transcortical motor	2	70.2 (7.5)	83.3 (5.6)	+13.1* (1.9)	+6.90	<0.05
transcortical sensory	1	74.9 —	81.3 —	+6.4 —	—	—
Wernicke's	6	38.4 (4.1)	48.4 (11.4)	+10.0 (7.1)	+1.40	>0.20

$*p < .05$

WAB's language subtests. Mean values of the AQ rose after treatment by +10.5* points [10.5%*]. Table 3 also shows details of AQ improvements after treatment in each of the aphasia diagnostic categories. Figure 1 shows AQ changes after treatment, plotted against years postonset when those changes took place.

Functional communication improvements after treatment

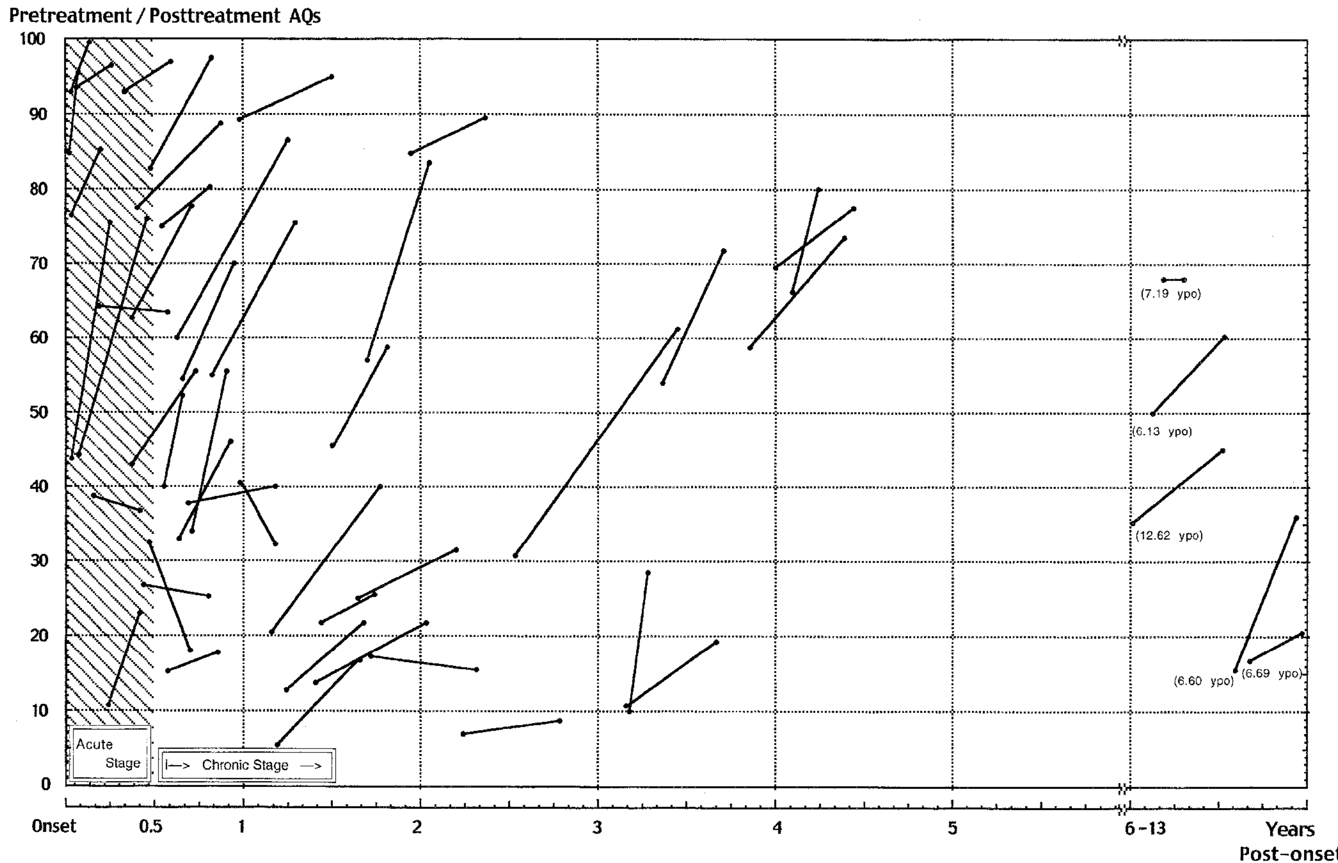
Mean scores of the 50 patients improved significantly following treatment on every one of the 16 CETI items. Expressed as absolute percentages, these improvements ranged from +8.4%* to +26.2%* with p values ranging from $p < .01$ to $p \ll .0001$. Table 4 presents details of improvements after treatment on each of the CETI's 16 items individually. CETI Overall means, of items 1–16 combined, improved after treatment by +18.2* points (18.2%*). Table 4 also shows details of CETI Overall improvements after treatment in each of the aphasia diagnostic categories. Figure 2 graphically displays these changes of CETI Overall means for each of the 50 patients, plotted against years postonset when the improvements took place.

Relationships between impairment-level and functional-level assessments

By pretreatment aphasia diagnoses. Tables 3 and 4 allow us to calculate a rank order correlation coefficient for the aphasia diagnostic categories at the levels of impairment and functional communication respectively. A high correlation suggests that these patient categories as assessed by these two very different instruments, administered by two different groups, for quite different purposes and in very different ways, nonetheless reflect a coherent picture of patient involvement prior to start of LCC treatment. Table 3 shows us that—for groups with $n > 2$—AQ rank ordering, moving from most to least severely involved, yields: global, Broca's, Wernicke's, conduction, anomic. Table 4 shows us that, for the same groups, analogous CETI Overall rank ordering yields: global, Wernicke's, Broca's, conduction, anomic. Comparison of pretreatment rank orders shows a similar pattern at impairment- and functional-levels, with a Spearman rank-order correlation calculated at the highly positive value of $\rho = +.90$.

In contrast, improvement patterns after LCC treatment, by diagnostic category, are not found to be similar at the impairment- and functional-levels. Again using data from Tables 3 and 4, we inspect improvements after treatment in the various aphasia diagnostic categories. At the impairment level, rank ordering, from smallest to greatest improvement after treatment, yields: anomic, global, Wernicke's, conduction, Broca's. At the functional communication level, the analogous type of ranking yields: conduction, Broca's, global, anomic, Wernicke's. Calculation of the Spearman rank-order correlation yields a value of $\rho = -.60$, indicating moderate negative correlation. After participation in these treatment programmes, then, mean improvement by diagnostic group shows in fact a certain divergence at the different assessment levels.

Post-treatment improvements by level of pretreatment severity. An analysis of post-treatment improvements for each of the four quarters of pretreatment severity, at both the impairment level and the functional communication level, provides a useful complement to the immediately preceding findings. For impairment-level analysis, the relevant data are found graphically displayed in Figure 1. We calculate the improvements after treatment of those patients whose pretreatment AQs fall into four groups, namely: [1]



n = 50 $\Delta = +10.5$ $t_{obs} = 7.53$ $p << .0001$

Figure 1. WAB aphasia quotients vs years post-onset.

TABLE 4
CETI (functional communication) improvements following treatment

CETI item no.	*n*	*Pre-treatment mean (SE)*	*Post-treatment mean (SE)*	*Difference of means (SE)*	t_{obs}	*p*
1	50	70.3 (4.0)	78.7 (3.4)	+8.4* (2.7)	+3.05	< 0.01
2	50	36.5 (4.0)	62.7 (3.7)	+26.2* (3.4)	+7.83	< 0.0001
3	50	56.0 (4.2)	77.5 (3.3)	+21.5* (3.4)	+6.43	< 0.0001
4	50	55.0 (4.2)	75.3 (3.0)	+20.3* (2.9)	+6.89	< 0.0001
5	50	70.7 (3.5)	82.9 (2.5)	+12.2* (2.4)	+5.05	< 0.0001
6	50	35.3 (4.4)	61.3 (3.9)	+26.0* (3.7)	+7.02	< 0.0001
7	50	42.9 (4.3)	64.1 (4.1)	+21.2* (3.2)	+6.55	< 0.0001
8	50	39.4 (4.9)	54.6 (4.6)	+15.2* (4.2)	+3.64	< 0.001
9	50	52.4 (4.2)	69.6 (3.8)	+17.2* (3.1)	+5.51	< 0.0001
10	50	37.0 (4.7)	51.6 (4.6)	+14.6* (3.5)	+4.22	= 0.0001
11	50	58.4 (3.8)	76.1 (3.3)	+17.7* (3.0)	+5.83	< 0.0001
12	50	31.1 (4.1)	48.7 (4.6)	+17.6* (3.8)	+4.58	< 0.0001
13	50	40.8 (4.8)	60.1 (4.3)	+19.3* (3.1)	+6.21	< 0.0001
14	50	24.2 (3.6)	41.1 (4.0)	+16.9* (2.7)	+6.20	< 0.0001
15	50	25.3 (4.0)	43.1 (4.2)	+17.8* (3.5)	+5.08	< 0.0001
16	50	15.4 (3.0)	34.0 (4.4)	+18.6* (3.4)	+5.51	< 0.0001
1–16 means	50	43.2 (2.7)	61.4 (2.8)	+18.2* (1.8)	+9.88	<< 0.0001
CETI Overall (1–16) improvements by aphasia diagnostic category						
anomic	8	58.0 (7.0)	80.3 (4.7)	+22.3* (4.2)	+5.33	< 0.001
Broca's	21	40.5 (3.0)	57.8 (4.0)	+17.3* (3.4)	+5.16	< 0.0001
conduction	6	49.4 (11.0)	59.2 (9.8)	+9.8* (1.8)	+5.49	< 0.01
global	6	30.7 (7.4)	50.1 (8.1)	+19.4* (5.0)	+3.86	< 0.01
tr.-mot.	2	46.6 (7.9)	64.7 (0)	+18.1 (7.9)	+2.29	> 0.20
tr.-sens.	1	36.5 —	52.7 —	+16.2 —	—	—
Wernicke's	6	39.2 (8.4)	62.3 (7.8)	+23.1* (5.4)	+4.31	< 0.01

* $p < .05$

below 25, [2] from 25 up to 50, [3] from 50 up to 75, and [4] 75 and above. There are 13 patients in group [1], and after treatment their mean AQ scores improved by +8.8*; there are 16 patients in group [2], and after treatment their mean AQ scores improved by +11.2*; there are 12 patients in group [3], and after treatment their mean AQ scores improved by +13.6*; and there are 9 patients in group [4], and after treatment their mean AQ scores improved by +7.9*. All improvements are significant. Inspection shows that the two groups in the middle—groups [2] and [3]—made greater gains than the groups at the extremes—groups [1] and [4]. This is a familiar pattern from other domains of rehabilitation, e.g., physical therapy, and the diminished improvements at the lower and upper extremes are sometimes referred to as ''floor effects'' and ''ceiling effects'' respectively.

At the functional communication level, we conduct a similar analysis using the CETI Overall scores in place of the AQ. For this level, the relevant data are found graphically displayed in Figure 2. Here, there are 8 patients in group [1], and after treatment, their mean CETI Overall scores improved by +20.8*; there are 29 patients in group [2], and after treatment their mean CETI Overall scores improved by +20.6*; there are 8 patients in group [3], and after treatment their mean CETI Overall scores improved by +13.0*; and there are 5 patients in group [4]; and after treatment their mean CETI Overall scores improved by +7.7*. Again, all improvements are significant. Inspection shows a

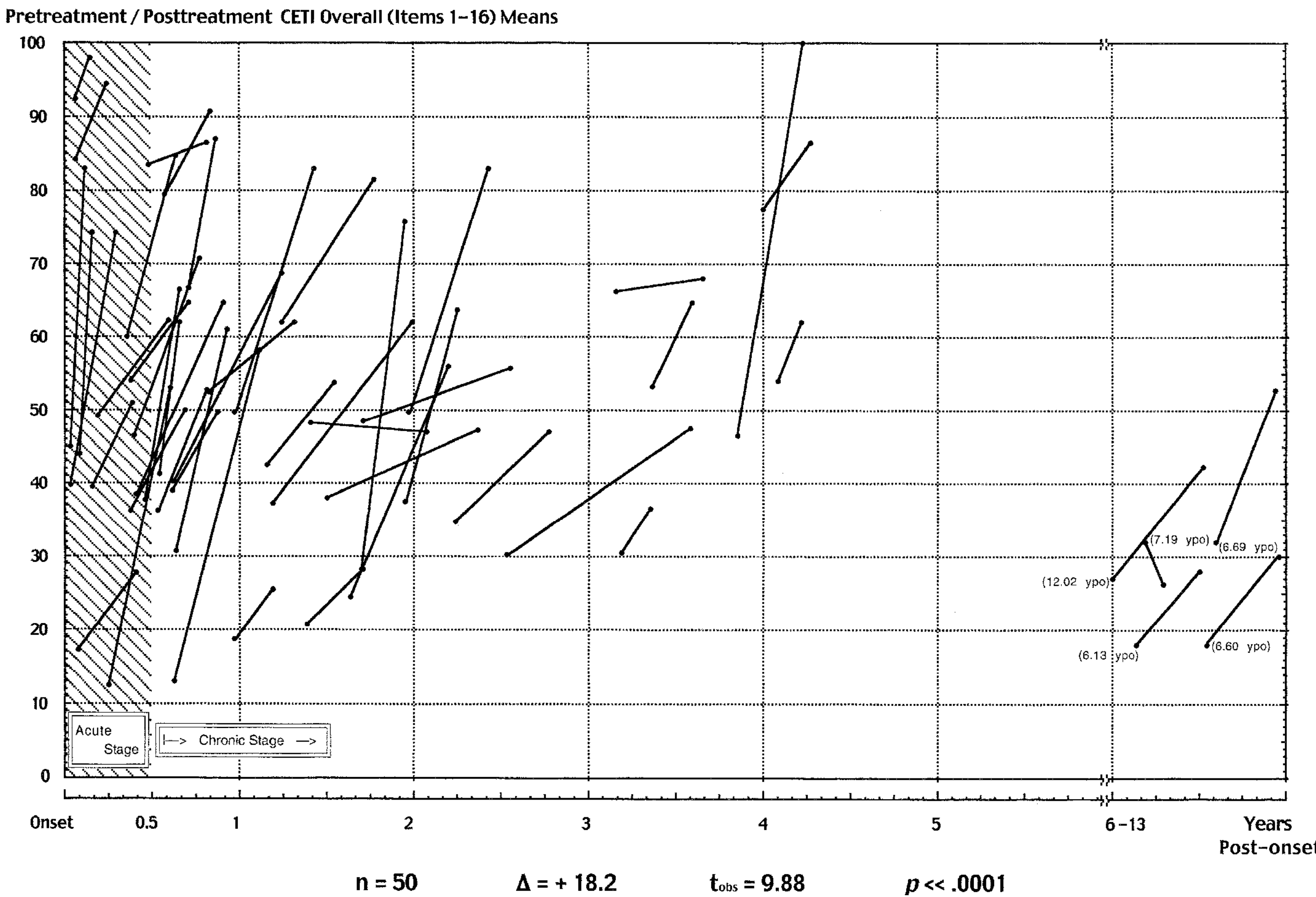


Figure 2. CETI Overall scores vs years post-onset.

fundamentally different pattern from that found at the impairment level. Specifically, the more severe the functional communication involvement before treatment in these programmes, the greater the functional communication gains, absolutely, following treatment in these programmes. In other words, one finds the (inherently unavoidable) ''ceiling effect'', but—at the functional level—no ''floor effect''.

DISCUSSION

The current report is an outcome study, the proper topics of which are the existence, direction, magnitude, and statistical significance of changes between two points in time. Data from outcome studies do not support the drawing of further conclusions regarding, for example, absolute efficacy, comparative efficacy, or attribution of causality. These latter issues require controlled experimental studies for their resolution, commonly the pursuit of research aphasiologists from academic settings. Despite limitations, however, it is of note that outcome studies are a variety of research which is assuming ever greater importance in the environment of managed care (Ellwood, 1988). There are cogent reasons for this: the requisite data are gatherable in ongoing clinical operations, they provide the underpinnings for programmatic continuous quality improvement, and they also yield crucial data for cost-effectiveness comparisons between competing programmes.

Aphasia following stroke has been extensively characterised taxonomically, anatomically, and—more recently—linguistically and physiologically (Benson, 1979; Brookshire, 1997; Darley, 1982; Goodglass, 1993). Research studies documenting responses to particular speech therapy interventions—using primarily impairment-level measures—are also widely published and evaluated (Appelbaum, & Steele, 1998; Holland et al., 1996; Robey, 1994, 1998). Less fully established in the literature, however, are changes in patients' disability-level (i.e., functional communication) measures following treatment, either under academic research protocols or through community-based treatment programmes. The limited relevance of improved impairment scores to improved functional communication, with poor correspondence between standardised test performance scores and functional ratings, has been previously pointed out by Sarno, as well as the relative lack of research in this area (Sarno, 1984). Still, a comprehensive survey article on the efficacy of aphasia treatment, published by Holland et al., concluded that best available evidence predicted the existence (without suggesting magnitude, statistical significance, or patterning) of patients' functional improvements in response to treatment (Holland et al., 1996). Even such indirect evidence as was cited there derived primarily from academic research, rather than from community-based treatment programmes where most persons with aphasia in fact receive therapy services.

The data presented here on disability-level and impairment-level performance improvements corroborate and extend prior findings from community-based LCC treatment programmes (Aftonomos et al., 1997; Aftonomos, Appelbaum & Steele, 1999; Aftonomos & Steele, 2000; Appelbaum & Harris, 1998; Appelbaum & Steele, 1998). Significant improvements after such treatment are corroborated for every language subtest of the WAB, for the WAB AQ, and for functional communication generally as assessed by the CETI Overall (mean of 16 items). Significance is here established for improvements in each of the 16 items taken individually on the Communicative Effectiveness Index. Moreover, with a sample sizes here notably greater than 30 both for impairment-level and for disability-level items, the improvement means and standard deviations reported represent, by the central limit theorem, fair approximations to the underlying population means and standard deviations (Downie & Heath, 1970). Thus, persons with aphasia who received care in these community-based programmes are shown to perform, in the mean, at significantly improved levels following discharge on every item assessed, whether at the impairment (speech-language test performance) level or at the disability (functional communication) level.

We note that there is no linear, one-to-one relationship—either in magnitude or in pattern—between improvements of impairment and function: rather, relationships appear to be multidimensional and complex. Previous experience suggests a conceptual model of possible utility here. According to this model, seminal impairment-level changes set the stage for the emergence of important functional improvements. A rather concrete example is the functional difference between C5 and C7 tetraplegia—a difference of just two motor levels occurring at a critical position with respect to upper extremity innervation. These small impairment-level gains are pivotal in establishing conditions for incremental functional performance gains. Conceptually, somewhat related mechanisms may be hypothesised to operate in the rehabilitation of the patient with aphasia. That is, key improvements of impairment-level measures in the various modalities (e.g., auditory verbal comprehension, naming, repetition, etc.) may—in differing combinations—be leveraged to establish anew conditions for successful participation in communicative transactions that were formerly beyond the patient. In this context, the noncongruence of changes between impairment and function is explicable in principle; and the suggested model may open the door to investigations of potential theoretical and clinical value.

While *changes* after LCC treatment at impairment and functional levels may not be linearly correlated, disability-level assessments nonetheless do show an accord with impairment-level assessments, when describing relative degree of aphasia severity as viewed from the differing SLP and family perspectives. In the present patient sample, for instance, pretreatment orderings of aphasia diagnostic categories by functional and by impairment severity accord well, as seen by the strongly positive + .90 correlation between pretreatment AQ and CETI. This latter finding is all the more surprising in view of well-known differences between the WAB and the CETI in overall aims, administration procedures, and designated assessors. Given the basic differences, the current findings suggest that—although clinicians and family members may diverge in assigning importance to various capabilities in aphasia (Lomas, Pickard, & Mohide, 1987)—they nonetheless arrive at broadly congruent senses of the overall relative negative effects for patients of the various aphasia diagnostic categories, at least before participation in these treatment programmes.

Patient sample bias, along with test instrument choice and employment, are potentially sources of error in this study. Patients arrived at these programmes through referrals, which means that this is not a random sample of persons with aphasia but rather one of patients who, in the judgement of referral sources, would be able to participate in therapy and make significant functional gains. Such judgements, of course, reflect not only referrers' knowledge of patients, but also their impressions of treatment programmes and treatment value. We are aware of this possible bias concerning patient selection, but such referrals to speech-language therapy constitute the majority of patients involved in treatment in community-based programmes. Previous analysis suggests that patients referred to these LCC programmes broadly mirror the caseload of community aphasia clinics in all demographic and diagnostic parameters save time after onset, in which they are far deeper, in the mean, into the period of chronic aphasia (Aftonomos et al., 1997; Aftonomos et al., 1999; Pedersen et al., 1995) Also, the fact that the treating therapists, who were not blinded, administered the pretreatment and post-treatment testing is a potential source of data bias, as may also be the psychological sets of family members when completing the CETI before and after treatment. The extent to which these potential sources of error may bias the data is unclear.

Our results are viewed through the test instruments that we have chosen. Several factors motivated the choice of the CETI for assessment of functional communication. The CETI focuses on situations of identified communicative prominence and importance to persons with aphasia and those close to them (Lomas et al., 1987, 1989) It directly rates observed communicative performance in patients' activities of daily living, rather than relying on testing in the clinic. It was specifically designed for sensitivity to change between two points in time, which makes it an especially suitable instrument for an outcome study. It stipulates scoring by someone—such as a spouse, sibling, or adult offspring—who was close to the patient premorbidly and familiar with their earlier communicative style (thus complementing here the perspective of the treating clinician, who provides the WAB impairment-level assessments). Finally, the CETI is relatively quick and simple to rate and score.

For impairment-level assessment, we chose the WAB, which can clearly differentiate between normal and aphasic language and which has demonstrated good test–retest reliability. In both instances, we elected to use one assessment instrument only, in the interests of consistency and comparability; and each instrument has its limitations. It is possible, for example, that the WAB may not have been sensitive to small changes in language performance, which could have been detected by other, more specific or specialised instruments. The CETI, in turn, may have left unassessed some areas examined by the lengthier CADL or ASHA FACS (Frattali et al., 1995; Holland, 1980).

In conclusion, then, this report documents—after treatment—significantly improved scores in every measure assessed, whether at the impairment level or at the functional level, whether assessed by SLPs or by family members. Such improvements are shown to be available to patients in chronic as well as acute aphasia, and independent of diagnostic type of aphasia, severity at start of care, or geographic programme location. They hold as well across communicative situations in natural settings. Perhaps most strikingly, the greatest gains in functional communication after treatment are registered precisely among those who are rated as most severely involved functionally prior to treatment. These results are being reported at a time when there is still widespread scepticism as to the true value medically of speech-language therapy for aphasic patients. Under capitated systems, clinical facilities have increasingly been finding themselves contending with sharp curtailments of authorisations for speech-language pathology services (Kearns, 2000). In this context, it is submitted that—with positive outcomes of such ubiquity, magnitude, and significance as those reported here—the present study provides a glimpse into domains whose elucidation should reward future researchers and clinicians with returns of significant theoretical as well as practical value.

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Improving Outcomes for Persons With Aphasia in Advanced Community-Based Treatment Programs

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Background and Purpose—Studies have yet to document that community-based aphasia treatment programs routinely produce results comparable or superior to published research protocols. We explore this issue here in an outcome study of individuals with aphasia enrolled in 2 community-based, comparably managed and equipped therapy programs, which use a specially designed computer-based tool that is employed therapeutically in adherence to an extensive, detailed, and formally trained patient care algorithm.

Methods—Patients (n=60) were assessed before and after treatment with standardized instruments at both the impairment and the disability levels. Pretreatment and posttreatment means were calculated and compared, with statistical significance of differences established with the use of 1-tailed matched *t* tests. One-way ANOVAs were used to analyze the comparability of patient performance changes among various subgroups, eg, patients in acute versus chronic stages of aphasia, patients by aphasia diagnostic type at start of care, patients by severity level at start of care, and patients by treatment location.

Results—Analysis shows that patients spanned a wide range of aphasia diagnostic types, impairment severity levels at start of care, and times after onset. Patients' mean performance scores improved significantly in response to treatment in all measures assessed at both the impairment level and the functional communication level. Mean overall improvements ranged from 6.6% to 19.8%, with statistical significance ranging from $P=0.0006$ to $P<0.0001$. ANOVAs revealed no significant differences between improvements in patients in the acute versus chronic stages of aphasia, between those at different impairment severity levels at start of care, between those treated at different locations, or, at the functional level, between those with different diagnostic types of aphasia at start of care.

Conclusions——Measures of both language impairment and functional communication can be broadly, positively, and significantly influenced by therapy services that are delivered to persons with aphasia in these community-based programs. The significant improvements are shown to be available to individuals with chronic as well as acute aphasia and independent of diagnostic type of aphasia, impairment severity at start of care, or geographic program location. **(*Stroke*. 1999;30:1370-1379.)**

Key Words: aphasia ■ rehabilitation ■ therapy, computer-assisted ■ treatment outcomes

Approximately one third of stroke patients will suffer the disruptive, often devastating consequences of aphasia.[1] The efficacy of aphasia treatment, including computer-based interventions, has been widely evaluated by individual studies,[2–13] by expert opinion after literature review,[14,15] and by meta-analysis.[16,17] The general consensus is that aphasia therapy is helpful for improving specific measures of language function if delivered over a sufficient period of time with adequate intensity. Holland et al,[14] for example, concluded in 1996 after thorough literature review that "considering this evidence collectively in its most conservative form, the conclusion can be drawn that people who become aphasic following a single, left-hemisphere thromboembolic stroke and who receive at least 3 hours of treatment each week for at least 5 months, regardless of the time post-onset of stroke, make significantly more improvement than people with aphasia who are not treated."

Such conclusions derive from results achieved primarily in the context of academic research; however, it is primarily in the community that individuals with aphasia must be identified, reached, and treated. There, given current healthcare constraints, the establishment and maintenance of programs for effective aphasia remediation are posing myriad new challenges. Nonetheless, the long-term viability of aphasia therapy depends on its ability to promote and improve functional outcomes in real-world settings of constraints and

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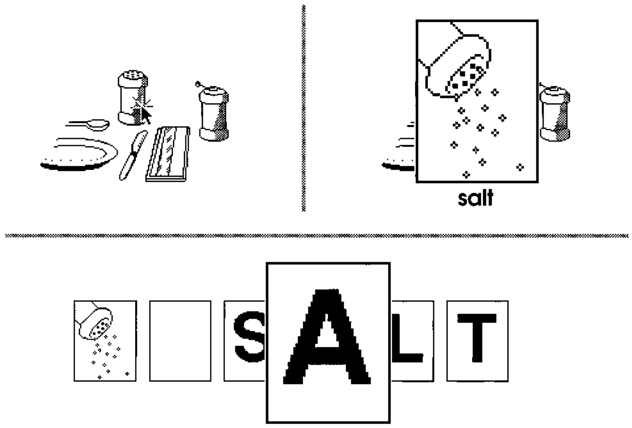

Figure 1. Icon appearances and behaviors.

limitations. In light of this, and building on work reported elsewhere,[18–20] we present relevant experiences from community-based aphasia therapy programs that use both a consistent, structured treatment methodology[21] and standard pretreatment and posttreatment testing at both the impairment (speech-language test performance) and the disability (functional communication) levels.[22]

Subjects and Methods

Treatment Programs

The 2 community-based treatment programs participating in this study are located in different parts of the country and provide speech-language therapy services to adults for reimbursement. One of these is a freestanding, for-profit speech-language clinic in Palo Alto, Calif (PA site), and the other is an outpatient facility owned and operated by a for-profit hospital in Kansas City, Kan (KC site). Operationally, both programs are similarly organized, equipped, and managed. Both sites offer comparable, formally structured speech-language therapy.

Descriptions of these programs, organizationally and operationally, appear elsewhere.[18,20,21] They are distinguished by the presence of several key components, including the following: (1) an extensive and detailed patient care algorithm, which helps treating clinicians specify therapeutic clinical pathways; (2) an online database that captures, holds, and reports patient demographic, diagnostic, assessment, treatment, and response-to-treatment data; (3) a proprietary treatment technology called the Lingraphica System, providing access to, among other things, an extensive toolbox of specially designed, interactive multimodal materials for use with and by patients; and (4) a formal training program for the speech-language pathologists who must competently draw on and integrate use of the preceding 3 components. Figure 1 shows representative appearances and behaviors of selected icons from the treatment technology and illustrates icon use in one type of therapy exercise, namely, "icon plus spelling."

Subjects

Subjects in this study were drawn from individuals diagnosed with aphasia and treated in one of the community-based treatment programs. Referrals for treatment in these programs came from physicians, hospitals, other community-based programs, speech-language pathologists, friends, family, and self-referral. To qualify for inclusion in this study, subjects had to meet 3 criteria: (1) assignment to 1 of 8 aphasia diagnostic categories through administration of the Western Aphasia Battery (WAB)[23]; (2) completion of at least 1 month of therapy in the community-based program; and (3) receipt before and after treatment of the language subtests from the WAB. We did not require subjects to be either right-handed or primarily English speaking.

Demographic, diagnostic, and treatment characteristics of the subject sample are presented in Table 1. Subject language diagnoses spanned the full spectrum of the 8 aphasia types from the WAB, with cases of global, Wernicke's, Broca's, and anomic aphasia combined accounting for 53 of the 60 cases (88.3%). Forty-six of the 60 subjects (76.7%) were ≥6 months after onset, placing them beyond the presumed period of spontaneous recovery and into the period of chronic aphasia; the remaining 14 subjects (23.3%) were still in the period of acute aphasia (<6 months after onset) at start of care.[24–26] For 53 of these 60 subjects (88.3%), Center-based treatment represented resumption of therapy after discharge from 1 or more previous courses of speech-language therapy elsewhere.

The subject sample reported on here accrued from the referral streams of the 2 programs. Analysis of the fates of referrals to these programs reveals a stepwise winnowing process, with patient numbers diminishing at each step. For example, during the accrual period at the PA site, a total of 258 patients were referred as potential candidates for benefit. After speech-language evaluation, 185 of the 258 were given a treatment diagnosis of one or another type of aphasia (as opposed to other treatment diagnoses, such as voice disorders or apraxia of speech). After resolution of any scheduling, transportation, and support issues, 170 were enrolled in treatment. Of the enrollees, 143 received treatment for ≥30 days. Of those, 105 were assessed before treatment with the WAB (others, particularly during the earlier period of this program, received instead the Boston Diagnostic Aphasia Examination,[27] whose results were reported in an earlier article).[18] Of these latter, 64 received posttreatment assessment with the WAB, with 52 receiving the relatively complete posttreatment assessment that allows for the calculation of the Aphasia Quotient (AQ) of the WAB. The current PA sample comprises the first 30 of this latter group chronologically. Of the 12 cases without the AQ-required administration of all first 4 WAB subtests (and who are not described in this article), analysis shows that the Spontaneous Speech subtest was omitted in 7 cases, the Auditory Verbal Comprehension subtest was omitted in 8 cases, the Repetition subtest was omitted in 3 cases, and the Naming subtest was omitted in 7 cases, in various overlapping patterns. Two subtests not involved in the calculation of the AQ were also omitted in some of these administrations: the Reading subtest in 13 instances and the Writing subtest in 26 cases.

Treatment

Patients participated in therapy with their treating clinicians in individual, hour-long sessions. Table 1 presents quantita-

TABLE 1. Patient Characteristics (n=60)

Characteristic	Mean (SD)	Range	Differentiation	No. (%) of Subjects
Sex			Male	35 (58.3)
			Female	25 (41.7)
Age at start of care, y	68.6 (12.3)	24–86	<60 y	10 (16.7)
			≥60 y	50 (83.3)
Years after onset	2.05 (2.33)	0.02–12.02	<0.5/acute	14 (23.3)
			≥0.5/chronic	46 (76.7)
Etiology			L-CVA	57 (95.0)
			TBI	1 (1.7)
			Hypoxia	1 (1.7)
			Unknown	1 (1.7)
WAB aphasia assignment at start of care			Broca's	21 (35.0)
			Anomic	13 (21.7)
			Global	11 (18.3)
			Wernicke's	8 (13.3)
			Conduction	3 (5.0)
			Transcortical motor	2 (3.3)
			Transcortical sensory	1 (1.7)
			Isolation	1 (1.7)
Treatment duration, wk	20.5 (10.7)	4.00–46.7		
Treatment frequency, sessions/wk	2.07 (0.55)	0.64–3.92		
Standardized assessment				
WAB			Speech-language impairment	60 (100.0)
CETI			Functional communication	29 (48.3)

L-CVA indicates left cerebrovascular accident; TBI, traumatic brain injury.

tive information on treatment for subjects in this sample. The overall mean number of treatment sessions per patient was 41.7 (SD 24.1; range, 10 to 132).

In clinical sessions, therapists typically employed stimulus-response strategies in treatment activities, using stimuli from specified materials loaded on the treatment technology. For any particular patient, of a given aphasia diagnostic type, at a given level of severity, the patient care algorithm suggests clinical pathways through a sequence of therapeutic exercises that have been found in our experience to be beneficial to patients of the given type. During treatment, focus was invariably on improving patients' functional communication outside the clinic, as opposed to training for higher scores on discharge retesting. When patient responses in therapy sessions so indicate, batteries of exercises are loaded onto the patient's system as prescribed home practice. At home, patients are to complete the prescribed clinical exercises, and additionally they may pursue materials of their own choosing, explore semantic domains to review lexical items within, or find other activities that engage their interest. Analysis has shown that patients typically engage in such self-directed activities approximately 2 hours per day.[18] Patients were discharged from treatment when any of the following occurred: (1) progress in functional communication reached a plateau as determined by the clinician; (2) funding became unavailable for continued therapy; or (3) intercurrent medical or other problems required discharge. Most patients were discharged because of the first condition, reaching a plateau in their functional communication.

Tests

Treatment program procedures specify administration of the WAB[23] and, more recently, the Communicative Effectiveness Index (CETI)[28] to persons with aphasia at start of care and at discharge. The former provides assessment at the impairment level, and the latter provides assessment at the disability (functional) level.[22]

The WAB, in addition to assessing speech-language impairment overall, assigns patients to 1 of 8 aphasia diagnostic categories and also provides an overall quantitative metric of aphasic severity: the AQ, which ranges from 0 to 100. The WAB has been psychometrically characterized and found valid and reliable.[29] Its 6 language subtests were administered in their entirety to this sample, except for 9 subjects in whom the Reading subtest was not completed (1 in the PA program, 8 in the KC program) and 23 subjects in whom the Writing subtest was not completed (8 in the PA program, 15 in the KC program). The reason most frequently given by clinicians for failure to complete all WAB subtests was lack of time.

The CETI was administered at start of care and at discharge to 13 PA patients and 16 KC patients of more recent enrollment. It provides ratings of functional performance of patients in important communicative activities of everyday life, as assessed by persons with opportunities for observing them frequently in relevant situations. The CETI consists of a 16 visual analog scale items assessing areas of functional communication in the patient's living environment. It is designed to be administered by caretakers and has been shown to be sensitive to change in

TABLE 2. Analyses of Responses to Treatment at Impairment and Functional Levels

Item	n	Pretreatment Mean (SD)	Posttreatment Mean (SD)	Difference of Means (SD)	t_{obs}	*P*
Impairment level (WAB)						
Spontaneous Speech	60	7.8 (6.3)	10.2 (6.5)	+2.4* (3.3)	+5.63	<0.0001
Auditory Verbal Comprehension	60	125.9 (51.2)	139.5 (50.1)	+13.6* (18.6)	+5.67	<0.0001
Repetition	60	39.0 (35.9)	45.6 (36.3)	+6.6* (11.0)	+4.66	<0.0001
Naming	60	30.4 (31.1)	39.1 (32.8)	+8.7* (11.4)	+5.92	<0.0001
Reading	51	47.4 (26.2)	54.8 (24.2)	+7.4* (14.0)	+3.80	=0.0004
Writing	37	28.4 (22.8)	37.2 (28.7)	+8.8* (14.2)	+3.74	=0.0006
AQ	60	42.5 (27.4)	51.6 (28.7)	+9.1* (8.8)	+7.98	<0.0001
Functional communication level (CETI)						
Means of 16 items	29	42.8 (19.0)	62.6 (18.6)	+19.8* (12.5)	+8.51	<0.0001

*$P<0.05$.

communication behaviors. The CETI has been psychometrically characterized and found valid and reliable.[28]

All testing and rating were accomplished in standard ways, assessing subjects' unaided, natural-language performance, without the specialized treatment technology. Specifically, the WAB was given to subjects by a trained and licensed speech-language pathologist familiar with its contents and practiced in its administration and scoring. The CETI, in turn, was rated by a person who was close to the subject and who also was familiar with that person's communicative strengths and weaknesses in activities of normal everyday living. This rater was most commonly a spouse, sibling, or adult child of the subject, less commonly a close friend, neighbor, or caregiver. As a rule, patients had no access to test materials between start of care and discharge (on average >20 weeks apart) to minimize the likelihood of practice effects accounting for patient performance improvements.

Statistical Analysis

Data were analyzed with the use of Data Desk 6.0 software on a Macintosh Quadra 840AV. Using raw WAB and CETI scores, we calculated pretreatment and posttreatment means and compared them with 1-tailed matched *t* tests.[30] WAB AQs were also calculated for subjects and analyzed. When significant differences were found with the use of matched *t* tests, 1-way ANOVAs were conducted to explore a possible further dependence on additional parameters, such as aphasia diagnostic category at start of care, impairment severity of aphasia at start of care, program location, or patient assignment to acute versus chronic aphasia. When the 1-way ANOVA revealed a significant difference, post hoc analysis was conducted with the Bonferroni test to identify underlying factors.[31] Finally, the χ^2 test was used to probe the significance of the distribution of aphasia diagnostic types among chronic patients after treatment compared with their pretreatment distribution.[30] Throughout, the level for rejection of the null hypothesis was set at $P=0.05$. Where achieved, statistical significance is denoted below by an asterisk (*).

Results

Table 2 shows pretreatment and posttreatment mean scores (raw) for all assessed areas, with associated observed *t* values and *P* values for the differences of means. For the WAB language subtests, absolute percent mean improvements were as follows: Spontaneous Speech, +12.0%* ($P<0.0001$); Auditory Verbal Comprehension, +6.8%* ($P<0.0001$); Repetition, +6.6%* ($P<0.0001$); Naming, +8.7%* ($P<0.0001$); Reading, +7.4%* ($P=0.0004$); Writing, +8.8%* ($P=0.0006$); and AQ, +9.1%* ($P<0.0001$). For the functional communication items from the CETI, absolute percent improvement overall was +19.8%* ($P<0.0001$).

Figure 2 graphically displays the AQ changes of the 60 subjects versus the times after onset. Of the 60 subjects in the study, 55 (91.7%) showed a higher AQ score after treatment, while 5 (8.3%) showed a lower AQ score. Figure 2 shows that these improvements are found across severity levels at start of care and throughout the range of times spanned after onset in this sample.

Figure 3 graphically displays the CETI overall changes available for 29 of the patients versus the times after onset when the changes occurred. Analysis of CETI score changes before and after treatment showed improvement in all 29 patients tested. Figure 3 reveals that all patients improved, regardless either of the initial level of severity or of the time after onset when they received the treatment.

Fourteen patients were still in the acute stage of recovery (<6 months after onset) at start of care, while the remaining 46 were in the stage of chronic aphasia (≥6 months after onset). Mean AQ improvement in patients in the acute stage was +8.0* points (SD 10.9, $P=0.017$), while in patients in the chronic stage mean AQ improvement was +9.4* points (SD 8.2, $P<0.0001$). One-way ANOVA showed no significant difference between these groups ($F_{1,58}=0.28$, $P=0.597$) with respect to AQ improvement.

Analysis of mean pretreatment and posttreatment CETI overall scores revealed significant improvement in both the acute and chronic groups. Among patients in the acute group (n=10), the CETI improvement was +23.3* (SD 11.2, $P=0.0001$), while in patients in the chronic group (n=19), the improvement was +17.9* (SD 13.1, $P<0.0001$). One-way ANOVA reveals no significant difference between these groups ($F_{1,27}=1.24$, $P=0.275$) with respect to CETI overall improvement.

Figure 4 shows AQ changes in the sample as a function of AQ severity at start of care. Twenty-one subjects fell into the

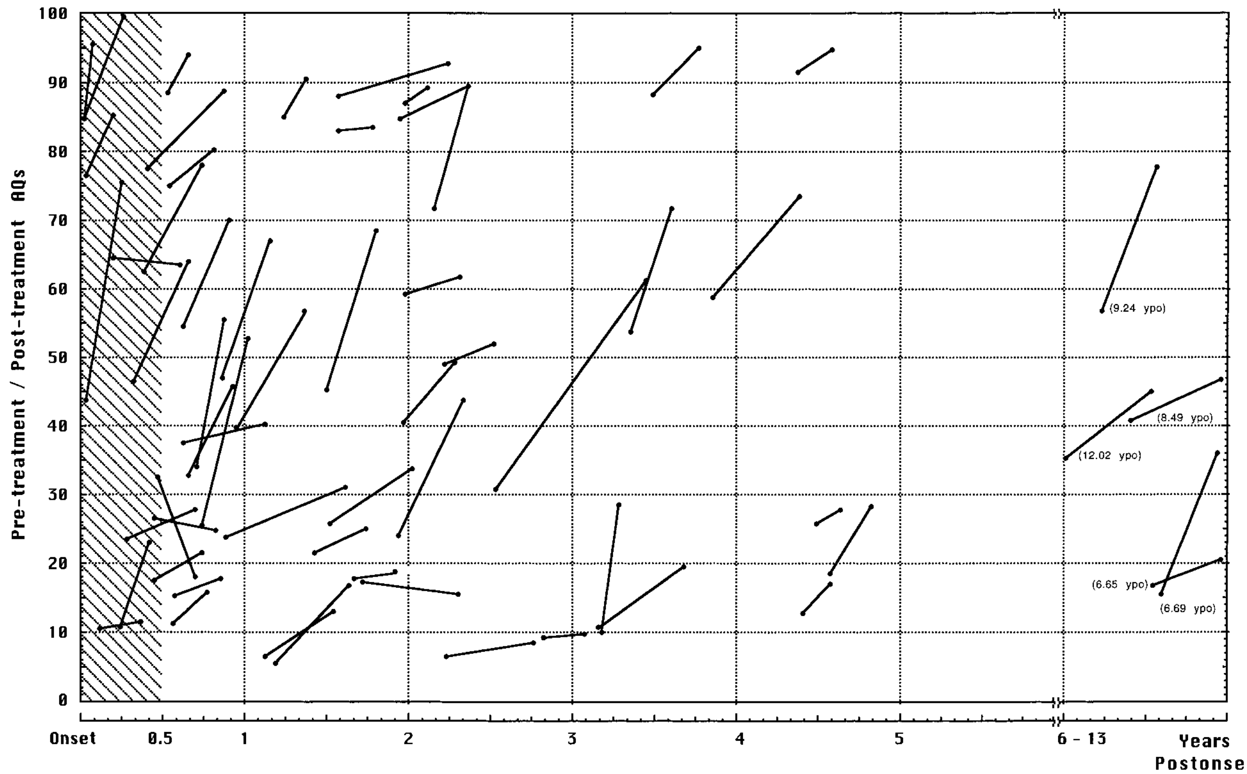

Figure 2. Speech-language impairment (AQ) changes vs years after onset (ypo).

lowest quarter (AQ <25), and in response to treatment their mean AQ score improved +6.7* (SD 6.1, P=0.0001). Eighteen subjects fell in the low-mid quarter (AQ 25 to 50), and in response to treatment their mean AQ score improved +12.6* (SD 12.1, P=0.0004). Nine subjects fell into the high-mid quarter (AQ 50 to 75), and in response to treatment their mean AQ score improved +12.2* (SD 7.5, P=0.0013). The remaining 12 subjects fell into the highest quarter (AQ

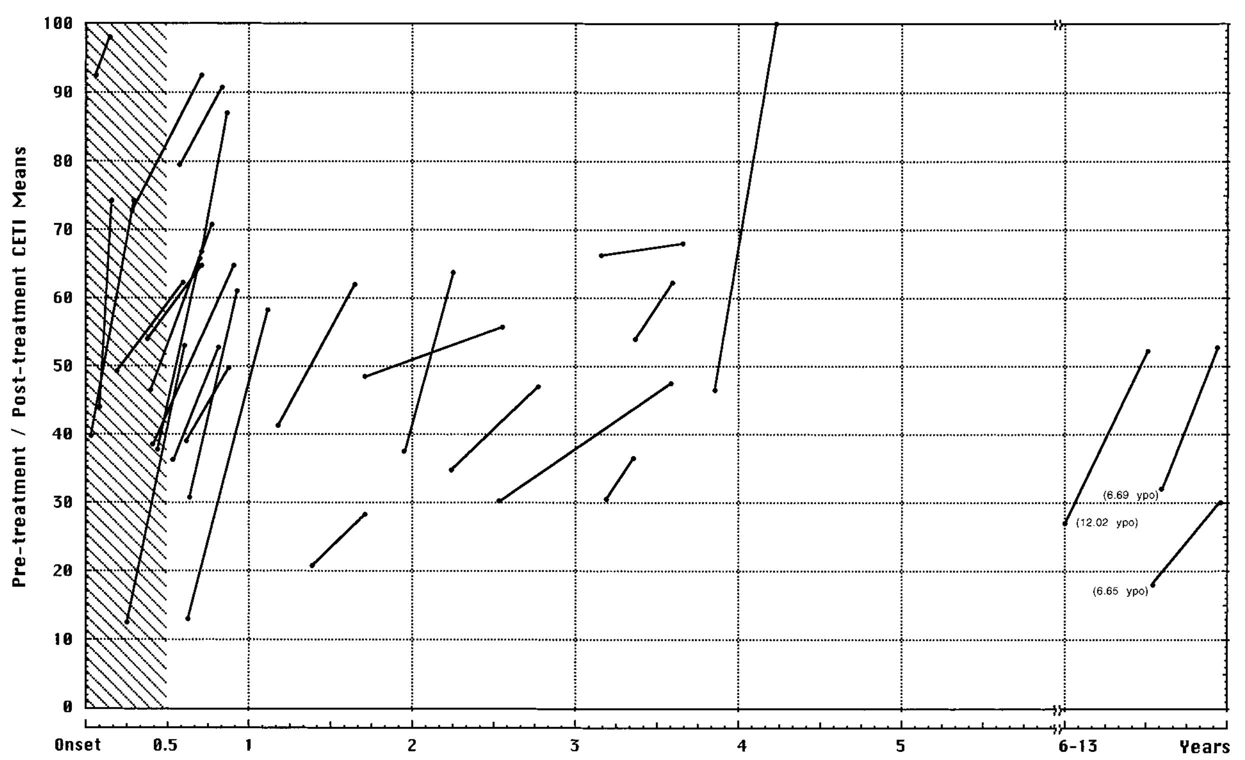

Figure 3. Functional communication (CETI) changes vs years after onset (ypo).

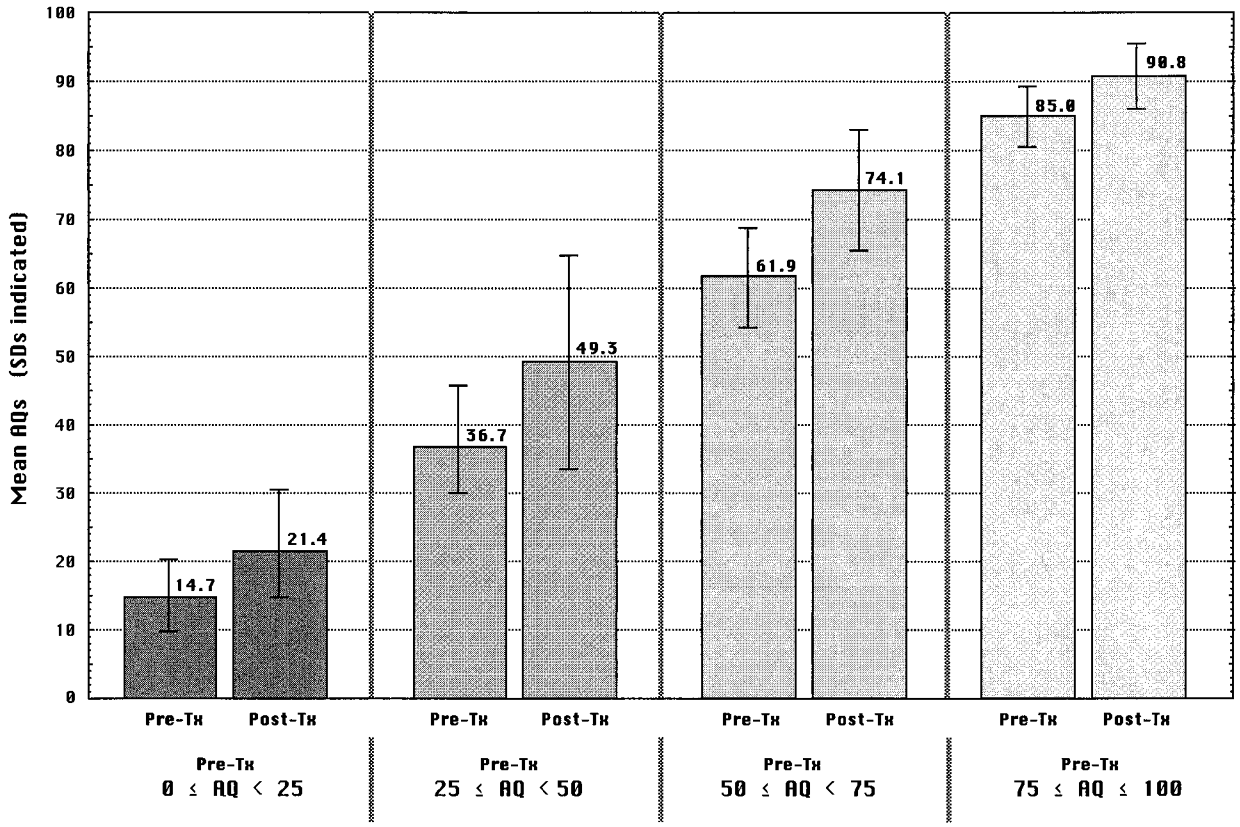

Figure 4. Speech-language impairment (AQ) changes at 4 levels of severity at start of care.

>75), and in response to treatment their mean AQ score improved +5.8* (SD 5.6, P=0.0041). One-way ANOVA revealed a trend toward significance in overall AQ responses to treatment among these groups ($F_{3,56}$=2.59, P=0.062). Figure 4 suggests that the trend toward significance may reflect floor and ceiling effects apparently manifesting in the lowest and highest quarters, in contrast to the middle 2 quarters.

When we compare the programs in different geographic locations, the 30 patients treated at the PA site showed a mean AQ improvement after treatment of +9.6* (SD 10.1, P=0.0001), while the 30 patients treated at the KC site posted a mean AQ improvement after treatment of +8.5* (SD 7.5, P=0.0001). One-way ANOVA of these AQ changes showed no significant difference between improvements at the 2 locations ($F_{1,58}$=0.26, P=0.61). In functional communication, the 13 CETI-assessed patients at the PA site showed a mean overall improvement after treatment of +24.3* (SD 13.6, P=0.0001), while the 16 CETI-assessed patients at the KC site showed overall improvement of +16.1* (SD 10.5, P=0.0001). One-way ANOVA of these CETI score changes revealed a trend toward significance at the 2 locations ($F_{1,27}$=3.41, P=0.076).

One-way ANOVAs showed no significant dependence of treatment parameters on aphasia diagnostic category at start of care. In particular, 1-way ANOVA of duration of treatment by aphasia diagnostic category ($F_{7,52}$=1.88, P=0.09), frequency of treatment by type of aphasia ($F_{7,52}$=1.19, P=0.33), and total number of treatment sessions by aphasia diagnosis ($F_{7,52}$=1.33, P=0.26) revealed no significant differences among the various aphasia categories at start of care.

Figure 5 graphically depicts, in dot plot format, AQ responses to treatment of all 60 subjects, grouped by their aphasia diagnostic categories at start of care. All categories showed overall improvement in response to treatment, and in the majority of categories in which n is >1, the improvements were significant. Thus, patients at start of care with Broca's aphasia (n=21) showed a mean AQ improvement of +13.9* points (SD=10.0, P<0.0001), those with anomic aphasia (n=13) improved +5.8* points (SD=6.4, P=0.007), those with global aphasia (n=11) improved +6.2* points (SD=3.9, P=0.0004), those with Wernicke's aphasia (n=8) improved +3.6 points (SD=10.1, P=0.347), those with conduction aphasia (n=3) improved +16.0* points (SD=5.5, P=0.038), and those with transcortical motor aphasia (n=2) improved +13.1 points (SD=2.7, P=0.092). One-way ANOVA of AQ changes by aphasia type at start of care revealed the presence of significant differences over the spectrum of aphasia categories ($F_{7,52}$=2.58, P=0.023). Post hoc analysis using the Bonferroni test showed that the overall significance resulted from trends toward significance in 2 pairwise category comparisons: Broca's (+13.9*) versus Wernicke's (+3.6), for which P=0.053, and Broca's (+13.9*) versus anomic (+5.8*), for which P=0.096. At the functional level as assessed by the CETI overall category, there were no significant differences among the aphasia categories available for analysis ($F_{6,22}$=0.41, P=0.87).

Table 3 shows the evolution in aphasia diagnostic categories in response to treatment among patients in the chronic

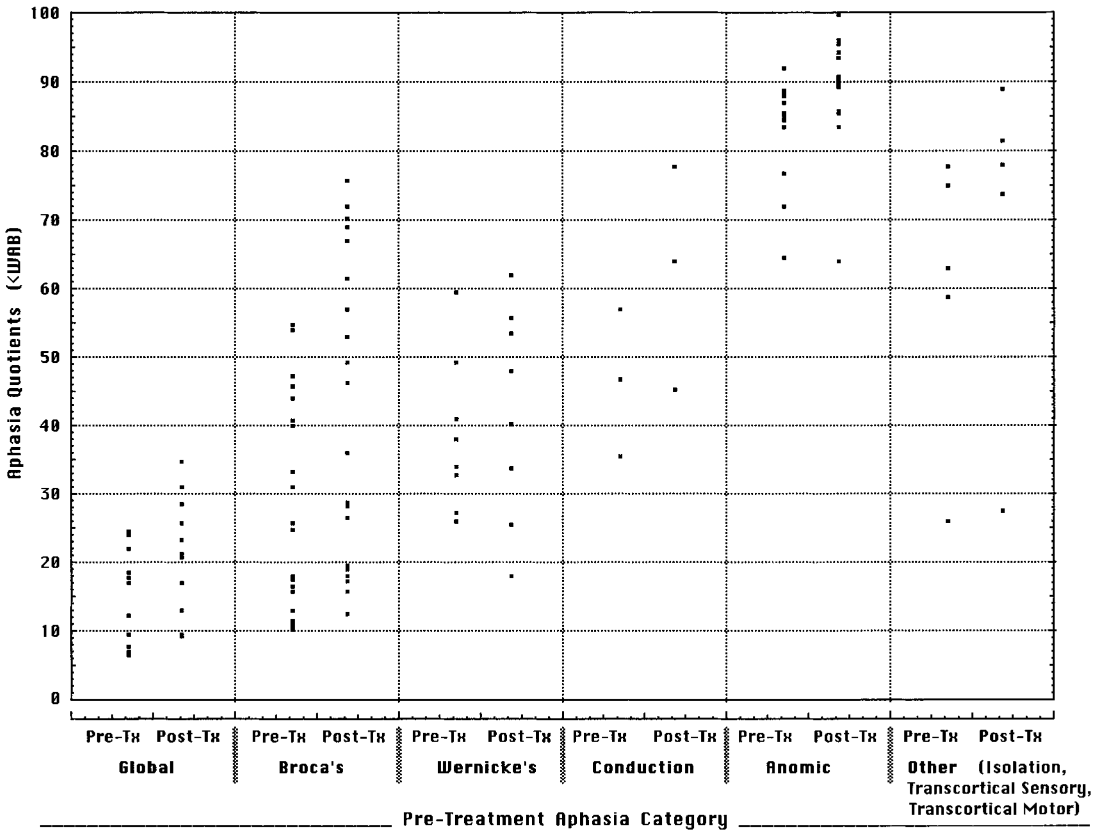

Figure 5. Responses to treatment (AQ) by aphasia diagnostic type (n=60).

stage (n=46). It is based on patients' WAB assignments to aphasia categories before and after treatment; however, to eliminate borderline cases, we required that reassignment to a different diagnostic category posttreatment be accompanied by a concurrent AQ shift, upward or downward, of ≥5.0 points from the pretreatment AQ score. By these criteria, 29 of the 46 patients in the chronic phase showed no change of diagnostic category after treatment, while 17 showed a change of aphasia type to a less severe diagnostic category (eg, from global to Broca's aphasia) accompanied by a rise in AQ score. No patients in the chronic phase showed a change to a more severe diagnostic category that was accompanied by an AQ drop of ≥5.0 points. This pattern is fundamentally different from that documented in the 1977 report of Kertesz and McCabe,[32] in which they followed 22 untreated persons in chronic aphasia longitudinally using the WAB. In that study, patients on the whole did not change AQ score significantly in a year's time, and only 1 patient changed diagnostic category (to a more severe category: from Broca's to global aphasia). A χ^2 test for changes among more severe, same, or less severe categories, with the published data of Kertesz and McCabe[32] as representative of the expected pattern, shows the present changes among 46 patients in the chronic stage to

TABLE 3. Evolution of Chronic Aphasia Types in Response to Treatment (n=46)

	Posttreatment Diagnosis								
					Transcortical				Within
Pretreatment Diagnosis	Global	Isolation	Broca's	Wernicke's	Motor	Sensory	Conduction	Anomic	Normal Limits
Global (9)	5 (+3.8)		*4 (+8.6)*						
Isolation (1)		1 (+1.9)							
Broca's (18)			11 (+11.0)		*1 (+14.8)*	*1 (+17.0)*	*5 (+20.2)*		
Wernicke's (6)			*1 (+7.8)*	4 (+4.0)			*1 (+21.5)*		
Transcortical sensory (1)								*1 (+6.4)*	
Conduction (2)							1 (+9.9)	*1 (+20.7)*	
Anomic (9)								7 (+4.1)	*2 (+6.4)*

In body of table (excluding Pretreatment Diagnosis column), more severe types of aphasia are toward top and left and milder types are toward bottom and right; same-type diagnoses are underlined; italics indicate a change of diagnostic category accompanied by an AQ rise of ≥5.0; patient counts are given outside parentheses, with average AQ improvements for those samples following within parentheses.

less severe diagnostic categories to be significant ($\chi^2_2=55.6$, $P<0.001$*).

Discussion

There is an extensive, often contradictory, literature on aphasia recovery and the impact of therapy. Since study methodologies vary, it can be difficult to compare individual studies and draw meaningful conclusions regarding the relative merits of any particular treatment approach. Depending on which study is cited, improvement may or may not occur in a given population. Wertz et al[6] elegantly demonstrated Porch Index of Communicative Abilities score improvements of up to 18.6 percentile points in intensively treated (8 to 10 h/wk) acute stroke patients, whereas Lincoln et al[4] were not able to show treatment effects for a group of 104 patients treated with less intensive (2 h/wk) therapy. Additionally, community-based studies whose main focus was not aphasia but that retrospectively inspected this parameter (and possibly more closely reflected the natural course of individuals with aphasia in contexts in which speech-language therapy is not always a primary focus) have reported little benefit from speech therapy in an aphasic stroke population.[1]

Many such studies are open to criticism on grounds of flawed design and/or execution.[33,34] Even when this is not the case, aphasia therapies are idiosyncratic and frequently highly individualized by the treating clinician to conform to a particular patient's unique combination of deficits and residual capabilities.[16,17] Because of such treatment variability, few therapy approaches are sufficiently defined and codified to lend themselves to critical evaluation. In this regard, the positive assessment recently accorded to melodic intonation therapy represents a laudable if instructive exception.[35] There is general agreement, however, that, on the condition that treatment intensity and duration exceed certain minimal thresholds, beneficial therapeutic effects can be demonstrated.[14,16,17]

In this context, we believed it important to investigate the effects of a community-based aphasia treatment program that provided therapy of known intensity using a structured and consistent therapeutic model and standardized measurement tools, thus diminishing effects attributable to varying treatment criteria, therapeutic approaches, and evaluation methods. We also believed it important to demonstrate our results in the context of the real-world financial constraints of current healthcare settings.

The data presented here corroborate and extend the pattern reported earlier of significant improvements in persons with aphasia treated through these programs, across a broad range of aphasia types, severities, and times after onset.[18–21] Moreover, with a sample size here considerably >30, the means and SDs herein reported represent, by the central limit theorem, fair approximations to the underlying population means for outcomes from these treatment programs.[36] ANOVA, furthermore, shows that the improvements are replicable across geographic sites. Of note, significance is herewith established for every language subtest of the WAB, for the WAB AQ, and for functional communication overall as assessed by the CETI. Lomas et al[28] found a mean gain of +11.4% in CETIs administered 6 weeks apart in recovering persons with aphasia undergoing speech/language therapy. This diverges from the current report of +19.8% gain, but neither the patient populations from which the samples were drawn nor the test-retest periods are comparable. In particular, the present patient sample was, in its majority, well into the chronic stage of aphasia and comprised mainly patients discharged from previous courses of speech-language therapy elsewhere.

Overall recovery from aphasia has been related to a variety of variables, including lesion size, aphasia type, and, perhaps most importantly, initial severity.[37] Recovery furthermore does not follow a random pattern but tends to move along more or less predictable paths. Kertesz and McCabe[32] noted that persons with global aphasia have the poorest prognosis, while anomic, transcortical, and conduction aphasics have the best. This formulation is consonant with the present findings. For example, Figure 5 shows that the present sample of persons with global aphasia at start of care had, on discharge, the poorest AQ profile of any diagnostic category, whether measured by lowest AQ score or highest AQ score; those with anomic, transcortical, and conduction aphasia had the highest AQ profile for these same measures. However, it is worth noting that the analogous statements hold for these same groups compared at start of care as well: those with global aphasia are ranked lowest, while those with anomic, transcortical, and conduction aphasia are ranked highest. What is most striking about Figure 5 in this regard is, in fact, the stability of pretreatment versus posttreatment order rankings of AQ means across diagnostic types, in the presence of such widespread and significant patient improvements. Patients emerge from these treatment programs with improvements spread relatively evenhandedly and equably across the diagnostic spectrum rather than concentrated in particular diagnostic categories. Interestingly, this is the improvement pattern that one would expect when the mechanisms underlying the remediation processes are of a general cerebral character rather than tied to more specific capabilities—psycholinguistic or other—that may be differentially compromised in the various aphasia diagnostic categories.

In addition, a relatively consistent pattern within aphasia diagnostic types is also discernible when data from Figure 5 are analyzed. This pattern includes the following, in comparing posttreatment scores with pretreatment scores of the same category: (1) a relatively small rise in the lowest AQ scores, with mean low score improvements in Figure 5 of +0.98; (2) a much larger rise in the highest AQ scores, with mean high score improvements in Figure 5 of +11.23; and (3) a notable extension of range between the highest and lowest scores, with a mean range extension in Figure 5 of 34.3% (from mean range=32.70 before treatment to mean range=43.93 after treatment). Such a pattern suggests a situation in which, within each diagnostic category, almost all patients improve somewhat, with the least impaired patients within categories more advantageously poised to derive additional benefits. In this regard, the ANOVAs conducted earlier in this article serve to underscore the fact that many of the traditional prognostic indicators, such as time after onset, severity at start of care, or aphasia diagnostic category, are in fact not those that differentiate between patients showing greater and lesser improvements after this treatment program. If this is borne out by further studies, the question of the relevant prognostic indicators for attainment of benefit from this treatment program must be considered.

To complicate matters, whether and how the "canonical" prognostic indicators correlate with response to therapy is even less well understood in chronic aphasia than in acute aphasia: fewer studies have been conducted, fewer subjects involved, and fewer hypotheses tested. In our chronic population, we were able to show a significant evolution to less severe aphasia diagnostic categories after treatment. Tantalizingly, these upward paths broadly recapitulate, diagnostically, natural courses of recovery from aphasia during the period of spontaneous recovery. Persons with global aphasia in our sample who improved all evolved to Broca's aphasia; persons with Broca's aphasia evolved to either conduction or transcortical aphasia; transcortical aphasia became anomic aphasia; and, when such evolution took place, persons with anomic aphasia at start of care performed within normal limits after treatment. These changes cannot be fully understood in terms of the expected underlying structural lesions of classic language areas[38]; rather, they support the notion of more widely distributed language mechanism underlying latent or residual language capacity.[15,39,40]

Patient sample bias, incomplete test administration, and choice of test instruments are potential sources of error in these results. Patients arrived at these programs through referrals, which means that this is not a random sample of persons with aphasia but rather one of patients who, in the judgment of the referral sources, would be able to participate in therapy and make significant functional gains. Such a sample will not include those individuals with aphasia—too low functioning, too high functioning, or other—who were deemed not treatable or not worth the effort of treating by referrers. In a study of 335 acute stroke patients with aphasia, Pedersen et al[1] reported 52% as severe, 16% as moderate, and 32% as mild on the basis of a 3-point scale. Twenty-one of the 60 patients (35%) in our study had AQs $<$25, and 9 of the 60 (15%) had scores in the top quartile, broadly consistent with the findings of Pederson et al. Although the 2 groups are not entirely comparable because our sample included persons with both acute and chronic aphasia, this suggests that our patients were fairly representative of the natural distribution of aphasia severity and therefore mirrored the typical caseload of community aphasia programs.

Some uncertainty in interpreting these results also arises from the fact that not all tests were administered to all patients. Absence of subtest scores for whatever reasons—perception of no improvement by treating clinician, patient at ceiling on pretest, lack of time for testing, or others—introduces distortions of unknown type, direction, and magnitude. In addition, our results are viewed through a specific set of test instruments. We elected to use one language measure exclusively, the WAB, in the interest of consistency and comparability. The WAB can clearly differentiate between normal and aphasic language and has demonstrated good test-retest reliability[23,29] but may not have been sensitive to small changes in language performance, which could have been detected by other more specific or specialized instruments. Similarly, a number of functional assessment instruments exist, each with a differing perspective on functional communication. We chose the CETI because of its demonstrated sensitivity to change and because it investigates the caregiver/family perspective of communicative function, which may not always coincide with the clinician's opinion.[41]

A large majority of patients treated in these specially equipped community-based aphasia treatment programs showed significant improvements in both language impairment and communicative function, regardless of time after onset, severity at start of care, or type of aphasia. In one sense, these findings should not surprise: indeed, they are in accord with the emerging view that patients in both acute and chronic aphasia may be candidates for significant improvement through resumption of treatment.[14,16,17] The corroborating evidence that is offered here comes specifically from an outcome study, the proper topics of which are the existence, direction, magnitude, and statistical significance of changes between 2 points in time. With these particular focuses, outcome studies represent a variety of research that is assuming ever-increasing importance in the environment of managed care.[42] This is because superior clinical outcomes, when available at competitive costs through replicable programs, are attractive to payers. Outcome studies also have their limitations. They do not, for example, allow the determination of conclusions regarding either absolute or comparative efficacy or for any attribution of causality. Answers to these latter questions come from properly designed, prospective, randomized, scientifically controlled research. It is hoped, in fact, that the present report will spur such research activity to investigate these latter questions. At present, for example, whether one specific element of the program or a synergy of components contributes more to these improved outcomes remains an open issue.

If the present findings warrant special interest, it would have to center on questions of why and how such changes—widespread, beneficial, and large—are taking place. These improvements strike not by ability to be documented but by their ubiquity, magnitude, generalization, and robustness. Aphasiologists have sometimes speculated about latent capacities for additional speech-language improvements that could be stimulated in late aphasia.[43] In preceding decades, such hypotheses could only remain speculation. More recently, brain imaging techniques have shown value in revealing significant relationships between language performance and brain functioning.[44] It is submitted that such newer study techniques must complement the more traditional, behaviorally based study methodologies, such as efficacy and effectiveness trials, to fully understand these outcomes, if we are to learn how best to proceed to improve the tools, materials, and methods for aphasia rehabilitation in community-based clinical practice.

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