

Steele, R.D. (2007, September). *Improvements in Chronic Broca's Aphasia at Impairment and Functional Communication Levels following SGD Practice and Use*. Paper presented at the 2007 Clinical AAC Research Conference, Lexington, KY.

Improvements in Chronic Broca's Aphasia at Impairment and Functional Communication Levels following SGD Practice and Use

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Abstract

In this study, we analyze WAB (impairment level) and CETI (functional level) assessment data for sixty nine persons in chronic Broca's aphasia who used a Speech Generating Device at home, under SLP guidance, for practice, therapy, and communication. After using matched *t*-tests to establish statistical significance of differences of means following SGD use, we investigate relationships between WAB AQ data and CETI Overall data pretreatment and posttreatment among subjects by impairment severity level. Data analysis reveals that mean scores improved significantly after SGD use at both levels on every measure assessed. While most subjects improved significantly within initial severity levels, a substantial minority moved up to less involved severity levels, or else to less severe diagnostic categories, with correspondingly larger quantitative improvements in both impairment-level and functional communication-level scores.

Research Description

An analysis of data from 46 persons in chronic aphasia published in a 1999 article in *Stroke* showed that – across the range of diagnostic categories of aphasia – not only did subjects show significant quantitative improvements in all measures assessed following Speech Generating Device (SGD) use, but that a substantial minority – approximately 37% – evolved to less severe diagnostic categories of aphasia, with correspondingly greater than mean improvements registered.¹ In this paper, we examine an larger data set from a single diagnostic category – chronic Broca's aphasia – for similar sorts of quantitative as well as qualitative improvements.

Methods

Subjects

Subjects were patients in aphasia rehabilitation programs using the Lingraphica SGD. Subjects used the SGD in scheduled treatment and training sessions with Speech

Language Pathologists, and also took them home between those sessions for completion of assigned exercises, for use in supporting communication, for practice and exploration, and for other uses of interest to them. To qualify for inclusion in this study, subjects had to meet four program criteria: i) assignment at Intake to one of the diagnostic categories of aphasia by the *Western Aphasia Battery* (WAB);^{2,3} ii) completion of at least one month of program participation; iii) assessment at intake and discharge using the language subtests from the WAB; and iv) assessment at intake and discharge using the sixteen items of the *Communicative Effectiveness Index* (CETI).⁴ Sixty-nine patients meeting these four criteria, and who were also at least six months postonset an intake, and were assigned following WAB administration at intake to the diagnostic category of Broca's aphasia, comprise the sample of this study.

Demographic, diagnostic, and treatment characteristics of the subject sample are presented in Table 1. Subject mean age was 62.9 y/o, most suffered a left CVA, subjects spanned the range from severe to mild Broca's aphasia, and subjects' mean time post-onset was 3.67 years. For most subjects, program participation represented a resumption of intervention following discharge from previous courses of speech-language therapy elsewhere.

Treatment

The aphasia rehabilitation programs, the SGD used in it, and participant benefits and outcome improvements are described elsewhere.⁵⁻¹⁰ Generally during treatment sessions, subjects and clinicians used the portable computer-based system for material presentation and interaction, then between sessions subjects took their systems home to complete assigned exercises, to explore, practice, rehearse on their own, and to facilitate functional communication. Program participation continued as long as significant functional improvement could be documented monthly; then subjects were discharged. Mean duration of program participation was 19.4 weeks, with a mean frequency of 1.9 sessions/week.

Tests

The WAB language subtests were administered by the SLP clinicians to all subjects at intake and at discharge. The CETI ratings were completed at intake and discharge by family members or close friends. All testing and ratings were all done in standard ways, absent the SGD technology, with the goal of assessing subjects' unaided impairment-level and functional-level performances.

Data Analysis

Using raw WAB and CETI scores, pre-treatment and post-treatment means were calculated and compared, with one-tailed, matched *t*-tests applied to establish statistical significance of differences of means. WAB Aphasia Quotients (AQs) were also calculated for subjects and analyzed. Mean values of raw WAB AQ and raw CETI Overall scores were calculated for comparison groups (*e.g.*, initial and final impairment severity levels, final aphasia diagnostic categories) and improvement magnitudes for these groups and statistical significance were also calculated. Level for rejection of the Null Hypothesis was set at $p = .05$.¹¹

Results

Analysis of data from the WAB shows significant improvement ($p < .0001$ to $p \ll .0001$) in all WAB language subtests and in AQs. Table 2 displays the data analysis results, with initial and final mean scores for subtests, differences of those means, and the associated t_{obs} and p values for the differences of means.

Analysis of data from the CETI shows significant improvement ($p \leq .0003$ to $p \ll .0001$) on each of the sixteen items assessed and in the CETI Overall. Table 3 shows the initial and final mean scores, differences of means, and associated t_{obs} and p values for those differences of means. For reference convenience, Appendix 1 spells out the sixteen items which are rated on the CETI.

Table 4 provides a more detailed look at improvements, organized now by initial impairment severity level. Here, the AQ range for Broca's aphasia (8 to 80) is divided into equal subranges of 24 points apiece. If $8 \leq \text{initial AQ} < 32$, the assignment is to *severe* Broca's aphasia; if $32 \leq \text{initial AQ} < 56$, the assignment is to *moderate* Broca's aphasia; and if $56 \leq \text{initial AQ} \leq 80$, the assignment is to *mild* Broca's aphasia. We see that at all three severity levels, after SGD use subjects improved significantly ($p \leq .0003$ to $p < .0001$) at both the impairment level and the functional communication level. One way analysis of variance reveals that there are no significant differences between the impairment-level (WAB) improvements as a function of initial severity ($F = 0.45$, $p = 0.64$). In contrast, there are significant differences among CETI Overall improvements ($F = 4.33$, $p = 0.02$), with subjects initially assigned to mild Broca's aphasia improving much more than those in the other two categories.

Table 5 further extends this approach, analyzing WAB AQ and CETI Overall improvements as a function not only of subjects' *initial* severity levels, but concurrently as a function of subjects' *final* severity levels, or (where applicable) of their reassignment to less severe aphasia diagnostic categories. Of the twenty-eight subjects initially assigned to severe Broca's aphasia, eighteen (64.3%) remained after SGD use at the severe level, while nonetheless making clinically and statistically significant improvements at both the impairment level ($\Delta\text{AQ} = +6.5$, $p = .0004$) and the functional communication level ($\Delta\text{CETI Overall} = +9.5$, $p = .0002$); seven subjects (25.0%) evolved to moderate Broca's aphasia, with larger significant improvements at both the impairment level ($\Delta\text{AQ} = +16.1$, $p = .0002$) and at the functional communication level ($\Delta\text{CETI Overall} = +15.0$, $p = .0008$); and three subjects (10.7%) evolved from severe to mild Broca's aphasia, with the largest significant improvements at both the impairment level ($\Delta\text{AQ} = +32.9$, $p < .0017$) and at the functional communication level ($\Delta\text{CETI Overall} = +20.0$, $p < .0047$). Similar patterns are documented at the remaining two initial severity levels, as shown in Table 5.

Discussion and Clinical Implications

Several points emerge from this study. First, for the sample of sixty-nine subjects with Broca's aphasia, mean scores are shown to improve significantly following SGD use on every measure assessed, at both the impairment level and at the functional level.

Second, the summary scores – WAB AQ for impairment, and CETI Overall for functional communication – show a similar pattern of significant improvement generally following SGD use when the data are analyzed by initial severity levels. Third, we observe that nearly half of the subjects (33 out of 69, or 47.8%) evolved out of their initial severity level following SGD use. And fourth, the qualitative changes are mirrored in score improvements that maintain appropriate and expected rank orders at both the impairment level and the functional communication level. These results document a significant subset of SGD users who show unusually large gains following SGD use, not reported previously.

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**Table 1: Demographic / Clinical Data Summary
for SGD Users in Chronic Broca's Aphasia (n = 69)**

<u>Characteristic</u>	<u>Mean (SD)</u>	<u>Range</u>	<u>No. (%)</u>
Gender			
male			36 (52.2)
female			33 (47.8)
Age (y)	62.9 (13.0)	24–83	67 (97.1)
Handedness			
left			51 (73.9)
right			3 (4.4)
unknown			15 (21.7)
Time postonset (y)	3.67 (4.23)	0.50–26.8	68 (98.6)
Etiology			
L-CVA			66 (95.8)
R-CVA			1 (1.4)
TBI			1 (1.4)
PPA			1 (1.4)
Intake Assessments			
WAB AQ	37.6 (17.2)	10.0–74.2	69 (100)
CETI Overall	40.0 (14.1)	3.5–79.6	69 (100)
Treatment			
frequency (sess/wk)	1.9 (0.6)	0.8 – 3.4	61 (88.4)
duration (wks)	19.4 (9.9)	5.1–53.9	69 (100)
Assessments at Intake and Discharge			
impairment level (WAB)			69 (100)
functional level			69 (100)

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Table 2: WAB (Impairment Level) Improvements in Chronic Broca's Aphasia following SGD Use

<u>Item</u>	<u>n</u>	<u>Initial Mean (SD)</u>	<u>Final Mean (SD)</u>	<u>Diff (SD)</u>	<u>t_{obs}</u>	<u>p</u>
Spontaneous speech	69	5.6 (3.9)	8.4 (4.5)	+ 2.8* (2.8)	+8.19	<0.0001
Aud. verb. comprehen.	69	140.0 (33.1)	153.4 (30.9)	+13.4* (16.5)	+6.73	<0.0001
Repetition	69	29.8 (24.3)	44.6 (27.7)	+14.8* (14.4)	+8.52	<0.0001
Naming	69	31.6 (25.1)	42.6 (28.8)	+11.0* (12.2)	+7.50	<0.0001
Aphasia Quotient (AQ)	69	37.6 (17.2)	49.7 (20.5)	+12.1* (9.2)	+10.92	<<0.0001

* $p < .05$

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**Table 3: CETI (Functional Communication) Improvements
in Chronic Broca's Aphasia Following SGD Use**

<u>CETI Item N°</u>	<u>n</u>	<u>Initial Mean (SD)</u>	<u>Final Mean (SD)</u>	<u>Diff (SD)</u>	<u>t_{obs}</u>	<u>p</u>
1	69	66.3 (28.6)	79.8 (21.0)	+13.5* (20.4)	+5.49	<0.0001
2	67	31.9 (27.6)	53.3 (27.1)	+21.4* (22.9)	+7.66	<0.0001
3	68	59.0 (26.2)	72.6 (23.7)	+13.6* (23.6)	+4.76	<0.0001
4	67	57.2 (27.1)	72.4 (24.7)	+15.2* (18.5)	+6.73	<0.0001
5	69	67.1 (25.0)	79.9 (19.5)	+12.8* (20.3)	+5.23	<0.0001
6	69	30.7 (26.4)	54.0 (29.3)	+23.3* (26.1)	+7.41	<0.0001
7	69	35.0 (28.0)	56.2 (29.8)	+21.2* (24.8)	+7.10	<0.0001
8	68	30.3 (28.8)	44.6 (31.2)	+14.3* (27.2)	+4.32	<0.0001
9	64	52.0 (28.9)	66.9 (25.6)	+14.9* (24.8)	+4.81	<0.0001
10	68	25.7 (26.9)	46.1 (28.7)	+20.4* (30.1)	+5.58	<0.0001
11	69	58.7 (28.2)	71.6 (25.8)	+12.9* (21.5)	+4.30	<0.0001
12	69	24.9 (26.8)	39.9 (29.0)	+15.0* (25.0)	+4.99	<0.0001
13	69	41.3 (30.8)	54.4 (29.4)	+13.1* (20.2)	+5.42	<0.0001
14	69	21.3 (22.5)	34.1 (25.6)	+12.8* (17.9)	+5.94	<0.0001
15	69	23.2 (24.5)	35.0 (25.7)	+11.8* (25.8)	+3.79	≤0.0003
16	69	14.7 (18.3)	28.3 (26.3)	+13.6* (20.7)	+5.47	<0.0001
1–16 Overall	69	40.0 (14.1)	55.5 (15.8)	+15.5* (14.3)	+9.01	<<0.0001

* $p < .05$

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**Table 4: Improvements by Initial Impairment Severity Level
in Chronic Broca's Aphasia, following SGD Use**

<u>Item</u>	<u>n</u>	<u>Initial Mean (SD)</u>	<u>Final Mean (SD)</u>	<u>Diff (SD)</u>	<u>t_{obs}</u>	<u>p</u>
Severe Broca's Aphasia ($8 \leq \text{WAB AQ} < 32$)						
WAB AQ	28	20.4 (6.5)	32.2 (13.8)	+11.8* (10.3)	+6.05	<0.0001
CETI Overall	28	42.2 (13.4)	54.2 (12.8)	+12.0* (8.4)	+7.56	<0.0001
Moderate Broca's Aphasia ($32 \leq \text{WAB AQ} < 56$)						
WAB AQ	28	43.0 (6.8)	54.4 (11.9)	+11.4* (8.9)	+6.76	<0.0001
CETI Overall	28	39.5 (16.9)	54.0 (16.6)	+14.5* (15.4)	+5.00	<0.0001
Mild Broca's Aphasia ($56 \leq \text{WAB AQ} \leq 80$)						
WAB AQ	13	62.7 (5.0)	77.0 (7.0)	+14.3* (7.5)	+6.89	<0.0001
CETI Overall	13	36.1 (7.3)	61.4 (19.5)	+25.3* (18.3)	+4.99	≤ 0.0003

* $p < .05$

**Table 5: Main Improvement Patterns within Initial Severity Levels
in Chronic Broca's Aphasia, following SGD Use**

<u>Initial Severity Level</u>	<u>n</u>	<u>Δ WAB AQ</u>	<u>Δ CETI Overall</u>
<u>Severe ($8 \leq AQ < 32$)</u>	28	+ 11.8*	+ 12.0*
Sev – Sev	18	+ 6.5*	+ 9.5*
Sev – Mod	7	+ 16.1*	+ 15.0*
Sev – Mild	3	+ 32.9*	+ 20.0*
<u>Moderate ($32 \leq AQ < 56$)</u>	28	+ 11.4	+ 14.5
Mod – Mod	10	+ 7.4*	+ 7.5*
Mod – Mild	3	+ 15.6°	+ 20.0*
Mod – Conduction	10	+ 17.1*	+ 22.4*
<u>Mild ($56 \leq AQ \leq 80$)</u>	13	+ 14.3	+ 25.3
Mild – Mild	1	+ 6.8	+ 14.4
Mild – Conduction	1	+ 10.0	+ 7.9
Mild – Anomic	9	+ 17.1*	+ 28.7*

* $p < .05$ ° $p < .10$

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Appendix 1: Items Rated on the *Communicative Effectiveness Index* (CETI)

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

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