

Research about SentenceShaper®: An Overview

WHAT IS SentenceShaper?

SentenceShaper is communication system designed to allow people with aphasia to create sentences and even narratives in their own voices. The program can be used for both communication assistance and language therapy. It was invented by Marcia Linebarger, PhD, a linguist with a background in the study of language disorders and computer processing of spoken language; and it has been studied in research grants conducted with internationally recognized neuropsychologists at two sites: Moss Rehabilitation Research Institute in Philadelphia (Myrna Schwartz, PhD) and the University of Maryland School of Medicine in Baltimore (Rita Berndt, PhD; Denise McCall, MA-CCC-SLP).

The design of SentenceShaper was inspired by research showing that people with aphasia may still know their language, but can't use this knowledge because language processing is slowed down – it takes longer to think of words, and words often vanish from memory before they can be combined into sentences.

The purpose of SentenceShaper is to tap into these hidden language abilities by “turning off the clock.” It allows the user to record spoken fragments, play them back, and build them into sentences by manipulating icons on a computer screen. The system requires no reading ability (an important feature, as reading and writing are often compromised in aphasia), and it can be customized for individual users and for languages other than English.

This fact sheet provides a brief overview of research studies about SentenceShaper; please contact us (info@sentenceshaper.com) for copies of any articles referenced below. Because we are summarizing published studies, statistical analyses and details of experimental design are omitted in this short review.

Two kinds of benefits: “Aided effects” and treatment effects

Two different kinds of positive effects from the system have been reported:

- *Aided effects:* Spoken utterances created while using SentenceShaper (aided utterances) are often far better -- in terms of grammatical structure, word choice, fluency, or other measures -- than utterances produced without using the system (unaided utterances).
- *Treatment effects:* For some people, these aided effects carry over into spontaneous, unaided speech after a period of SentenceShaper use. Their unaided multi-sentence narratives (on unpracticed topics) may become longer, more structured, more fluent, and/or more informative following regular home use of SentenceShaper for a period of time. This is an impressive outcome, because aphasia treatment rarely generalizes to connected speech (see, e.g., Berndt & Mitchum, 1995).

RESEARCH ON AIDED EFFECTS (Moss Rehabilitation Research Institute)

In the first study employing the system (Linebarger, Schwartz, Romania, Kohn, Stephens, 2000), six people with agrammatic aphasia learned how to create spoken narratives with SentenceShaper, and then practiced using the program for approximately 15 hours. After this, we elicited narratives (which had never been practiced during training) with and without SentenceShaper. The aided narratives (those produced with the system) were longer and more grammatically structured than the unaided versions (those produced spontaneously, without use of SentenceShaper) for five of the six participants, despite the fact that the version of the system used in this study

provided no word-finding help at all, just memory support. For two of these participants, the contrast between aided and unaided narratives was quite striking, as illustrated below.

**Descriptions of the same episodes produced with and without SentenceShaper
(from Linebarger et al., 2000)**

| <i>Unaided description (WITHOUT SentenceShaper)</i> | <i>Aided description (WITH SentenceShaper)</i> |
|---|---|
| Participant DB: | |
| The, the maid, the maid, the maid, uh, uh, upstairs and she, uh, the maid upstairs and 'scuse me' and um ... go around but now uh the The policeman, she she?, no, the man, two men, and the uh, oh, she, uh, her, she...knock them out, knock them out, um hum, knock them out, two men | The man goes around them. She did not do it. The nurse goes around the baby carriage. The policeman, she fights the, the two men. |
| Participant DD: | |
| “Ooh! A fish! Ah, water” and...uh mmm and attendant, “here,” and bumped his head. “Oh boy, oh my hand, my hand, my hand.” | The boy and the fishmonger is taking the fish. The boy hit his hand. |

Aided effects with a portable version of SentenceShaper

A recent study at Moss Rehabilitation Research Institute explored the use of SentenceShaper To Go™ (Linebarger, Romania, Fink, Bartlett, & Schwartz, 2008), a software suite allowing people with aphasia to download onto a portable handheld computer spoken utterances that they have created on SentenceShaper. This handheld computer can then be used to assist communication in a wide variety of real life situations (shopping, restaurants, travel, appointments with doctors and lawyers, personal advice, speeches, toasts, etc.). Some encouraging preliminary data from this study have been reported (Bartlett, Schwartz, Fink, Lowery, Linebarger, & Schwartz, 2007; Linebarger et al., 2008), and more detailed reports of the study are currently in preparation.

RESEARCH ON TREATMENT EFFECTS

A number of small studies have shown that extended use of the program may lead to improvements in spontaneous, unaided speech. These treatment effects (as opposed to aided effects, which refer to better speech with versus without the program) are more difficult to study than aided effects, because they require a period of extended use of the program, ideally at home; and, to date, considerable variability has been observed in the results of these studies.

Studies at Moss Rehabilitation Research Institute

The first study to show treatment effects – that is, the positive impact of SentenceShaper use on spontaneous, unaided speech -- was reported in Linebarger, Schwartz, & Kohn (2001). Two people with non-fluent aphasia participated in an extended treatment program in which the system was used alternately (but not concurrently) with another language therapy program. As indicated in Linebarger et al. (2001: Tables 7 and 9), the first 15 hours of home use of SentenceShaper (after several hours of training in the lab) had a marked impact on the quality of these participants’ unaided retellings of silent videos viewed before and after (but never during) training. For example, both participants showed changes in Median Length of Utterance; one participant increased from a median 2 words per utterance pre-training to 4 words per utterance post-training, and the other participant increased from a median 3 words per utterance pre-training to 5 words post-training.

These gains are particularly encouraging because they were achieved through largely independent home use of the system. After learning how to operate the program effectively, participants were provided with computers in their homes and asked to use the system to create narratives – describing life events, expressing opinions, or retelling movies and television shows.

In a subsequent project, SentenceShaper was used in the context of aphasia groups. In this project, participants met weekly in supported conversation groups and also underwent weekly training on the system, which was used for two “offline” functional purposes: email (productions on the system were emailed to friends and fellow group members as sound file attachments) and a group web site (photographs and other images were accompanied by spoken comments created on the system). In the second half of the study, participants were instructed to engage in regular homework constructing narratives on SentenceShaper. For six of the 10 participants in this phase of the study, impressive treatment gains were observed (Schwartz, Linebarger, Brooks, & Bartlett, 2007; some results reported in Linebarger & Schwartz, 2005:Table 1) across a variety of unpracticed narrative tasks, ranging from Cinderella story retellings to the less demanding task of describing wordless picture books; and across a number of different structural measures.

Studies at the University of Maryland School of Medicine

SentenceShaper treatment effects were studied in a recent project at the University of Maryland School of Medicine. As reported in Linebarger, McCall, Virata, & Berndt (2007) and McCall, Virata, Linebarger, & Berndt (2009), largely independent home use of SentenceShaper led to treatment gains reflected in structural measures (such as utterance/sentence length, proportion of words that occur in sentences, grammatical well-formedness), measures of informativeness, and/or speech rate.. Perhaps the most striking treatment outcome to date is reported in McCall et al. (2008). After using SentenceShaper at home for a period of 27 hours (over a five month period), the participant in this case study increased his Mean Sentence Length from 3.6 words per sentence to 8.12 words per sentence; after a second treatment in which the software was used to train subordinate clauses, his unaided sentence length increased further to 11.56 words per sentence. In addition, his utterances became more structured and well-formed; after the first treatment, for example, the proportion of his words that were in sentences rather than isolated fragments increased from 44% to 91%; the proportion of sentences that were well-formed increased from 7% to 76%. Below we illustrate the qualitative impact of these changes with excerpts from McCall et al. (2008; Table 4), comparing the first few utterances of this participant’s spontaneous, unaided retelling of a wordless picture book before and after the first treatment. This particular story was never practiced during treatment, of course; for a fuller sample of these pre-post narratives, please see McCall et al. (2008; Table 4).

Impact of first treatment on spontaneous speech: Excerpt from McCall et al. (2008; Table 4)

| <i>First four utterances BEFORE treatment</i> | <i>First four utterances AFTER treatment</i> |
|---|--|
| frog in the bottle | the boy and the frog is having a good time |
| frog in the top | the frog is getting out of the jar |
| frog in the window | the boy and the dog are sleeping |
| frog gone | the dog and the boy are aware the frog is gone |

The participant in this study was two years post-stroke, well past the 6-month period traditionally cited as the phase of spontaneous recovery. All participants in these SentenceShaper studies have been at least one year post-onset, in order to make sure that any treatment effects do not reflect spontaneous recovery.

SUMMARY

Research studies have demonstrated that some people can produce much better speech when they are using SentenceShaper than they can produce on their own, even if the program is modified to provide just memory

support, with no word-finding assistance. This is an exciting finding in itself, because it shows that people retain more linguistic ability than may be evident in their day-to-day-speech.

From a practical standpoint, these aided effects may potentially impact the lives of people with aphasia by allowing them to express their thoughts and desires more clearly, and to make it clear to other people that they are still intelligent human beings. The portable version of the program currently under study at Moss Rehabilitation Research Institute may allow people to leverage the effects of the system in a wide range of social situations.

However, as discussed in Linebarger et al. (2008), it can take a long time to create a message with the program. In fact, “turning off the clock” is a core function of the program; giving the user time to come up with words and play back his sentences in order to correct or expand them is exactly what underlies the aided effects reported above. Therefore, we believe that the program is most likely to be effective for messages that can be anticipated in advance (e.g., communications with store clerks, doctors, lawyers, transportation providers; speeches, toasts, advice; email and web postings); it is less likely to be helpful in highly interactive conversations on topics which the user cannot anticipate in advance.

The need for a way to demonstrate one’s preserved intelligence cannot be understated. Many people assume that the fragmented and halting speech of those with aphasia means that they are intellectually disabled and perhaps even child-like. For some individuals, SentenceShaper offers a means to reveal their preserved intelligence, humor, and compassion. For example, a participant in the Schwartz et al. (2007) study suffered from very severe word-finding problems, and was unable to communicate even a simple message about how to check books out of the library without a painful struggle:

Participant’s unaided production, created without SentenceShaper:

you uh find the book on the shelf ... and take it ... to the clerk or or um um ... I don’t know um ... and um ... um ... y- no um ... um ... um ... /rtln/ al- also we take out for two weeks ... and punch it at on the uh thing that you gave her uh the uh stamp or um um um ... card ... and ... you take the the book out of the library then.

This same individual produced the following empathic and insightful comments as part of an exercise in which people with aphasia played the role of “Dear Abby”; in this case, the advice was directed to a woman (“Mary”) who had written the columnist to ask whether she should break up with her obviously married boyfriend (“Jay”):

The same participant’s aided production, created with SentenceShaper:

Hello Mary. You date a boy named Jay. I know his phone number, but that all I know about him. He is married or sort of married. His wife is angry about your seeing him. You can’t go near the house ‘cause you don’t know where it is. You see Jay for less than a year. I think you are going out with the wrong fellow. Jay plan on deceiving you. There are many fish in the sea. So go out with a different guy. But don’t forget about Jay, the guy you originally love. God loves you. Think about it. Take a chance.

The program has also been used to create public speeches. Below are some links to public speeches created on SentenceShaper:

- See <http://www.sentenceshaper.com/aphasia-software/whatotherssay.html#wolpe> for details about a moving speech delivered to over a thousand people by a woman with aphasia. This speech is also mentioned in Fried (2002), *The New Rabbi* (pp. 150, 262).
- See http://www.adleraphasiacenter.org/pdf/Final_2006_Review_Book.pdf (page 5, “Back to the Council”) regarding a man who used SentenceShaper to prepare campaign speeches when he ran successfully for re-election to a local Town Council. SentenceShaper has been embraced enthusiastically by the Adler Aphasia Center in Maywood, NJ; organizations such as Adler, which focus on improving quality of life in people with aphasia, represent a natural milieu for SentenceShaper. This was also referenced in a *Wall Street Journal* article about the center (“Restoring Lost Speech after a Stroke”), available at <http://www.globalaging.org/health/us/2006/aphasia.htm>.

In addition to these aided effects, the sometimes-striking treatment effects from extended use of the program are exciting; they show that people can continue to improve their speech long after the period of spontaneous recovery has ended. It is also encouraging that SentenceShaper use in the studies reported above has been largely independent; after learning how to use the program, participants typically used the program independently in their homes and came into the lab once a week. This also adds support to the claim that linguistic knowledge is intact in these individuals, since they did not require any explicit instruction in the rules of English.

BUT....some caveats

It should be emphasized that results vary considerably across individuals, affected by aphasia type, severity, and other aspects of cognitive function, and that studies of the program’s treatment effects have, to date, involved relatively few participants and protocols that are difficult to control tightly (e.g., home use of the program); see, e.g., Beck (2007)¹. SentenceShaper is most likely to be effective for people who are able to produce some speech, and whose executive function and/or memory allows them to utilize a software program that requires executing certain actions in order (for example, turning a sound recorder on, speaking then turning the recorder off) and self-monitoring (playing back their utterances in order to correct and expand them).

While many people with aphasia show aided effects (that is, they produce better speech when using SentenceShaper than they can produce without the prosthesis), these effects do not always carry over into treatment effects (that is, spontaneous, their unaided speech may or may not improve). And people who do show treatment effects – that is, who demonstrate improvements in their spontaneous, unaided speech in laboratory tasks such as retelling narratives – may still experience great difficulty in stressful or highly interactive contexts. Thus treatment effects may be evident in certain social situations but not in others. Therefore, the program is most likely to be effective if it can be used as an assistive device as well as for solo practice aimed specifically at improving the user’s spontaneous speech. Regarding functional use, the literature on Augmentative and Alternative Communication (AAC) has documented that considerable support by family members, clinicians, or volunteers may be required to generalize aided effects from the laboratory to real-life, functional situations.

¹ Beck (2007) reviews the Linebarger et al. (2007) study, and points out the limitations of this small study to establish definitely the program’s treatment effects. Beck observes, correctly, the small number of participants, the variability of their neurological and language profiles, the hard-to-interpret variability in their treatment outcomes, the difficulty of controlling caregiver input and duration of system use in a home-based protocol, the lack of control participants and/or control conditions (due to the limited participant pool and the already-cumbersome length of the experiment), etc. All these factors underscore the need for a larger and more controlled study of the program’s treatment effects. However, it should be emphasized that assessing SentenceShaper’s aided effects should not pose the same methodological challenges, since extended use of the system may not be required to achieve aided effects (that is, better performance on the computer than without it).

OTHER RESEARCH ABOUT THE PROGRAM

- Robust aided effects and treatment effects were reported in an interesting case study conducted at the University of British Columbia (Albright and Purves, 2008). This study also addresses some of the challenges of making functional use of the non-portable version of SentenceShaper.
- Preliminary studies about the impact of SentenceShaper on automatic speech recognition (Dahl, Linebarger, & Berndt, 2008) suggest that the program may allow some people with aphasia to create utterances that are significantly more intelligible to speech recognizers than the same individuals' spontaneous, unaided speech. Because reading and spelling impairments are widespread in aphasia, speech recognition (along with text-to-speech software that plays text aloud) may eventually make it possible for people with aphasia to interact with others in text-based environments such as the Internet.
- Previous studies (Linebarger, Schwartz, & Kohn, 2001; McCall, Virata, Linebarger, & Berndt, 2009) have suggested that combining SentenceShaper use with structure-specific exercises (e.g., eliciting picture descriptions and providing models of the target sentence) may increase the program's effectiveness. This model underlies SentenceShaper 2, an enhanced version of the program to be released in the summer of 2009 (see <http://www.sentenceshaper.com/new-products/index.html>). SentenceShaper 2 incorporates images into the basic SentenceShaper interface. This new program displays pictures for the user to describe and provides word-finding support appropriate to each picture, allowing the user to create spoken picture descriptions and short narratives in the supportive environment of SentenceShaper. This new version of the program can also be used to create electronic scrapbooks pairing users' personal photographs with spoken commentaries created on SentenceShaper.

PUBLICATIONS about SentenceShaper

- Linebarger, M.C., Schwartz, M.F., Romania, J.F., Kohn, S.E., & Stephens, D.L. (2000). Grammatical encoding in aphasia: Evidence from a "processing prosthesis". *Brain and Language*, 75, 416-427.
- Linebarger, M.C., Schwartz, M.F., & Kohn, S. E. (2001). Computer-based training of language production: An exploratory study. *Neuropsychological Rehabilitation*, 11(1), 57-96.
- Linebarger, M.C., McCall, D., & Berndt, R.S. (2004). The role of processing support in the remediation of aphasic language production disorders. *Cognitive Neuropsychology*, 21, 267-282.
- Linebarger, M.C., & Schwartz, M.F. (2005). AAC for hypothesis-testing and treatment of aphasic language production: Lessons from a processing prosthesis. *Aphasiology*, 19, 930-942.
- Bartlett, M.R., Fink, R.B., Schwartz, M.F., & Linebarger, M.C. (2007). Informativeness ratings of messages created on an AAC processing prosthesis. *Aphasiology*, 21:5, 475-498.
- Linebarger, M.C., McCall, D., Virata, T., & Berndt, R.S. (2007). Widening the temporal window: Processing support in the treatment of aphasic language production. *Brain and Language*, 100, 53-68.
- Beck, A. (2007) Whether SentenceShaper®, a computerized communication system, supports production in individuals with aphasia remains to be seen. *Evidence-Based Communication Assessment and Intervention*, 1:3, 124-226.
- Fink, R.B., Bartlett, M.R., Lowery, J.S., Linebarger, M.C., and Schwartz, M.F. (2008) Aphasic speech with and without SentenceShaper: Two methods for assessing informativeness. *Aphasiology*, 22, 679-690.
- Albright, E., & Purves, B. (2008) Exploring SentenceShaper: Treatment and augmentative possibilities. *Aphasiology*, 22, 741-752.
- McCall, D., Virata, T., Linebarger, M., & Berndt, R.S. (2009) Integrating technology and targeted treatment to improve narrative production in aphasia: A case study. *Aphasiology*, 23:4, 438-461.
- Linebarger, M.C., Romania, J.R., Fink, R.B., Bartlett, M., & Schwartz, M.F. (2008) Building on residual speech: A portable processing prosthesis for aphasia. *Journal of Rehabilitation Research and Development*, 45:9, 1401-

1414.

- Dahl, D.A., Linebarger, M.C., and Berndt, R.S. (2008) Improving automatic recognition of aphasic speech through the use of a processing prosthesis. *Technology and Disability*, 20, 283-294.
- True, G., Bartlett, M.R., Fink, R.B., Linebarger, M.C., and Schwartz, M.F. (in press) Perspectives of persons with aphasia towards SentenceShaper To Go: A qualitative study. To appear in *Aphasiology*.

CONFERENCE presentations about SentenceShaper

- Linebarger, M.C., Romania, J.R., Kohn, S.E., Schwartz, M.F., & Locatelli, D. (1998) Competence versus performance in agrammatic production: Evidence from an Augmentative communication system. Presented to the annual meeting of the Academy of Aphasia, Santa Fe, NM, October 1998. [Abstract: *Brain and Language*, 65, 199-202.]
- Linebarger, M.C., Schwartz, M.F., Kantner, T., & McCall, D. Promoting access to the Internet in aphasia. Presented to the annual meeting of the Academy of Aphasia, New York, NY, October 2002 [Abstract: *Brain and Language*, 83, 169-172.]
- McCall, D., Linebarger, M.C., & Berndt, R.S. (2002) Retraining narrative production: Impact of processing support. Presented to the annual meeting of the Academy of Aphasia, New York, NY, October 2002 [Abstract: *Brain and Language*, 83, 172-175.]
- Schwartz, M.F. and Linebarger, M.C. In their own words: Investigations of a processing prosthesis for spoken language rehabilitation in aphasia. Keynote Address by Myrna Schwartz to the British Aphasiology Society, Newcastle upon Tyne, September 2003.
- Linebarger, M.C., & Schwartz, M.F. Assistive technology as a tool for the remediation and investigation of aphasic language production. Presented at the Aphasia Therapy Workshop, Vienna, Austria, October 2003.
- Linebarger, M.C., & Dahl, D. A. Applying speech technologies to language therapy and communication assistance. Presented to the annual SpeechTEK conference, New York, NY, September 2004.
- Linebarger, M.C., McCall, D., Virata, T., & Berndt, R.S. Supported versus unsupported narrative elicitation: Impact on language production in aphasia. Presented to the annual meeting of the Academy of Aphasia, Chicago, IL., October 2004. [Abstract: *Brain and Language*, 91, 44-46.]
- Linebarger, M.C., Schwartz, M.F., McCall, D., & Berndt, R.S. Using a 'processing prosthesis' to treat aphasic language production disorders. Presented to the annual meeting of ASHA, Philadelphia, PA, November 2004.
- Linebarger, M.C., Fink, R., and McCall, D. Clinical and functional use of a "processing prosthesis" for aphasia. Symposium presented at the annual ASHA Convention, Miami, FL, November 2006.
- Schwartz, M.F., & Fink, R. Aphasia rehabilitation in the age of computers. Presented at *SpeakingOut!2006*, Boston, MA, June 2006.
- Fink, R., Bartlett, M., Schwartz, M.F., & Linebarger, M.C. Informativeness ratings of messages created on an AAC processing prosthesis. (2006) Presented to the Clinical Aphasiology Conference in Gent, Belgium, May 2006.
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- McCall, D., Virata, T., Linebarger, M.C., and Berndt, R.S. Predicting structural effects of computerized intervention on aphasic speakers' production. Poster presented at the annual ASHA Convention, Miami, FL, November 2006.
- Bartlett M.R., Schwartz M.F., Fink R.B., Lowery J., & Linebarger, M.C. Spoken language enhancement with SentenceShaper To Go™, a portable AAC system based upon processing support. Presented to the annual meeting of the Academy of Aphasia, Washington, DC, October 2007 [Abstract: *Brain and Language*, 103, 217-218.]
- McCall, D., Linebarger, M.C., and Berndt, R.S. (2007) Predicting effects of computer based intervention on structure and content of aphasic patients' spoken language. Presented to the annual meeting of the Academy of Aphasia, Washington, DC, October 2007 [Abstract: *Brain and Language*, 103, 207-208.]

McCall, D., Virata, T., Linebarger, M.C., and Berndt, R.S. Integrating technology and targeted treatments for narrative production in aphasia. Poster presented at the annual ASHA Convention, Boston, MA, November 2007.

Linebarger, M. Assistive, rehabilitative, and investigative use of a “processing prosthesis” for aphasia. Poster presented at the Clinical AAC Conference in Lexington, KY, September, 2007.

Linebarger, M. Overcoming time barriers: can a “processing prosthesis” support functional communication?” Poster presented at the Living Successfully with Aphasia Conference, Toronto, ON, September 2007.

Fink, R.B., Bartlett, M.R., Gallagher, J.L., Linebarger, M.C., and Schwartz, M.F. Aphasic speech with and without *SentenceShaper*: Two methods for assessing informativeness. Paper presented at Clinical Aphasiology Conference, Scottsdale, AZ, May 2007.

Schwartz, M.F., Bartlett, M.R., Fink, R.B., True, G., & Linebarger, M.C. Assistive technology for spoken language in aphasia: Test of a portable enhancement of the SentenceShaper® Program. Poster presented at the 36th Annual International Neuropsychological Society (INS) Meeting, Waikoloa, Hawaii, February 2008.

SUBMITTED/UNPUBLISHED PAPERS

Schwartz, M.F., Linebarger M.C., Brooks R., Bartlett M.R. (2007) Combining assistive technology with conversation groups in long-term rehabilitation for aphasia. Unpublished manuscript, Moss Rehabilitation Research Institute. Available from: <http://www.ncrrn.org/pdf/SchwartzAssistiveTechnology.pdf>.

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RESEARCHERS

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CONFLICT OF INTEREST DISCLOSURE

SentenceShaper uses methods and computer interfaces covered by U.S. Patent No. 6,068,485 (Linebarger & Romania, 2000) owned by Unisys Corporation and licensed to Psycholinguistic Technologies, Inc. A potential conflict of interest arises because Marcia Linebarger serves as Director of Psycholinguistic Technologies. Therefore, she has not participated in testing or in scoring of raw data in any of the studies described above. No one else involved in the research has a financial interest in the software.

FOR FURTHER INFORMATION

Please contact Dr. Marcia Linebarger (Telephone: 215-525-9905; Email: linebarger@sentenceshaper.com) for further information or for reprints of the articles summarized above. You may also wish to visit our website, www.sentenceshaper.com.