Introduction

The *SentenceShaper*^{TM} (previously "Communication System", or "CS") is an AAC device designed to support spoken language production in aphasia by minimizing the temporal and working memory demands of real-time speech (Linebarger, Schwartz, Romania, Kohn, & Stephens, 2000). It allows the user to record spoken fragments and to associate these saved fragments with visual icons that can be played back, combined, and integrated into larger structures.

Linebarger et al., (2000) showed that individuals with chronic, nonfluent aphasia produced longer and more structured utterances in story narratives when they used the *SentenceShaper*. We refer to the improvements in language quality on vs. off the system as "aided effects." This study is concerned with extending the evidence for aided effects using speech samples and outcome measures with a higher degree of naturalness. Specifically, we assessed whether unfamiliar listeners would detect an aided effect when judging the *informativeness* of *functional narratives* produced with and without the system. Functional narratives were elicited by scenarios from the ANELT (Blomert, Kean, Koster & Schokker, 1994) (e.g., "You are in the drugstore and this [lost glove] is lying on the floor. You take it to the counter. What do you say?").

The primary prediction was for an aided effect, operationally defined as better speech with the *SentenceShaper* (SSR) than in the unaided (U) mode (SSR > U). A secondary prediction was for better *unaided* production of a functional narrative after its having been produced on the SSR ("aided-practice effect": Post-U > U). This prediction was motivated by prior research showing that practice in creating a variety of narratives on the *SentenceShaper* sometimes resulted in improved language (longer and more structured utterances) on spontaneously generated narratives that had not themselves been practiced (e.g., Linebarger, McCall, & Berndt, 2004).

Methods

Participants

Participants were five individuals with chronic aphasia (three Broca's, two Anomics; AQ range 67.4 – 79.8). All had participated in research a year or more earlier in which they produced picture and story-plot narratives on the *SentenceShaper*. Participants were refreshed on the basic features of the system before beginning this study.

Raters

Raters were thirteen SLP graduate students enrolled in an adult language disorders course.

Software

The *SentenceShaper* is described fully in Linebarger et al. (2000; 2004). Of particular relevance here is that it incorporates customized tools for word-finding support, primary among which are side buttons that play pre-recorded content. In order to incorporate this content into a production, the user must repeat and record it on the system.

Stimuli/Elicitation Procedures

Two preliminary phases preceded the production of rated samples. The first trained participants to produce ANELT narratives on a version of the *SentenceShaper* with five new side buttons that cued discourse headings ("hello", "the problem is…", "I want you to...", "I will...", and "goodbye"). Training encouraged participants to play and incorporate these cues into their *aided* productions. The second preliminary phase involved the designated experimental ANELT scenarios: *Lost Glove* and *Broken Glasses.* Across four to five biweekly sessions, participants repeatedly narrated completions to these scenarios (in counterbalanced order), *unaided and without feedback*. The last of each was submitted to raters as the U sample. In the sessions that followed, participants produced the rated SSR and Post-U samples, in that order. That the narratives were well practiced before the U sample was collected mitigates the possibility of U being judged less informative than SSR or Post-U simply on account of its having come first.

Rating Procedures

Listeners rated the samples using Direct Magnitude Estimation (DME) (Stevens, 1975; and for similar applications, Campbell and Dollaghan, 1992; Doyle et al., 1996; Jacobs, 2001). Each rated all narratives for one scenario (e.g., Glove), followed by all narratives for the other (Glasses). To assist listeners in rating informativeness (operationally defined as accuracy and completeness), they were shown the ANELT scenarios that elicited the narratives.

Rater Reliability

Intra-rater reliability was assessed by presenting selected samples twice during the rating session (Campbell & Dollaghan, 1992). Specifically, we selected at random three samples per scenario and interspersed them among the others. Rater reliability was measured on the six score pairs obtained from each rater.

Data Reduction and Analysis

Characteristic of DME, listeners used different number scales to rate informativeness. Ratings were therefore standardized to a scale of 0-100. Repeated measures ANOVAs were performed on the data from each participant, separately for Glove and Glasses. The dependent variable was standardized ratings; the within-subjects factor was Condition (U, SSR, Post-U). In each analysis, the effect of Condition was further analyzed by two planned contrasts: U vs. SSR, and U vs. Post-U. The criterion for significance was $p < .05$.

Results

Regarding rater reliability, examination of the absolute difference in ratings assigned to paired reliability samples resulted in elimination of one rater, whose extreme score differences qualified her as an outlier. Reliability for the remaining twelve was comparable to prior listener studies (e.g., Campbell and Dollaghan, 1992): median Spearman Rho for the individual raters was .80; Rho computed on all 72 stimulus pairs was .75; $p < .0001$.

As Table 1 shows, six of the RM-ANOVAs were significant for the Condition effect. Four participants (all but DCN) showed the effect for Glove and/or Glasses. Planned contrasts revealed that in every case where there was a Condition effect, SSR differed significantly from U in the predicted direction (SSR > U). This constitutes strong evidence for an aided effect.

(Table 1 here)

As to the aided-practice effect, ratings for Post-U differed significantly from U in the expected direction (Post-U > U) in three cases: EC on Glasses; MO on both scenarios. Table 2 shows transcripts for two cases. The Post-U samples convey content that was not mentioned in the U sample (or in any of the unaided practice samples) but appeared for the first time in the SSR sample. Such content (underlined in the table) plausibly represents carry-over from the aided production. Comparison of U and SSR samples exemplifies the aided effect.

(Table 2 here)

Discussion

Linebarger et al. (2000) showed that spoken productions composed by aphasic users on the *SentenceShaper* are enhanced, relative to spontaneous productions. The present results indicate that the language enhancement (aided effect) is not limited to story plot narratives, but occurs also in narratives with functional content. Equally important, this effect is not only demonstrable on laboratory measures of utterance length and grammatical structure; it is also evident to unfamiliar listeners, asked to rate the samples for their informativeness.

The difference in mean ratings for unaided narratives before vs. after the SSR-aided narrative served as the measure of carry-over from the aided production. The U, Post-U difference was significant for two participants (three scenarios). Relative to the aided effect, which was significant for four participants (six scenarios), this aided-practice effect is obviously weaker. Nevertheless, it may be important, for two reasons: First, it suggests that persons with aphasia may derive communicative assistance from practicing anticipated functional encounters ahead of time on the system. Second, it opens the possibility of more general gains, that is, treatment effects, arising over the course of extended use of the system for functional communication.

References

Blomert, L., Kean, M. L., Koster, C., & Schokker, J. (1994). Amsterdam-Nijmegan Everyday Language Test (ANELT): Construction, reliability & validity. *Aphasiology, 8*(4), 381-407.

Campbell, T. F., & Dollaghan, C. (1992). A method for obtaining listener judgments of spontaneously produced language: Social validation through direct magnitude estimation. *Topics in Language Disorders, 12*(2), 42-55.

Doyle, P. J., Tsironas, D., Goda, A. H., & Kalinyak, M. (1996). The relationship between objective measures and listeners' judgments of the communicative informativeness of the connected discourse of adults with aphasia. *American Journal of Speech-Language Pathology, 5*, 53-60.

Jacobs, B. J. (2001). Social validity of changes in informativeness and efficiency of aphasic discourse following linguistic specific treatment (LST). *Brain and Language, 78*, 115-127.

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., 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.

Stevens, S. S. (1975). *Psychophysics: Introduction to its perceptual, neural and social prospects*. New York: Wiley.

Table 1. Summary statistics for the standardized Direct Magnitude Estimation judgments of 12 raters, organized by participant (Pt.), Scenario (Glove, Glasses), and Condition (Unaided (U), Aided (SSR), Post-Unaided (Post-U)).

										Repeated Measures ANOVA		
		Unaided (U)			Aided (SSR)			Post-Unaided			Condition Main Effect		
Pt.	Scenario	Mn	SD	SE	Mn	SD	SE	Mn	SD	SE	F	p	Contrasts
EC	Glove	42.6	19.9	5.7	82.1	19.4	5.6	32.1	14.6	4.2	34.4	< .0001	SSR > U
	Glasses	12.6	12.6	3.6	52.7	25.1	7.2	41.3	23.6	6.8	11.5	< .001	SSR > U; PU > U
MAI	Glove	55.7	26.4	7.6	69.2	19.6	5.7	46.9	25.8	7.5	3.2	n.s	n.s.
	Glasses	73.8	18.7	5.4	91.6	11.6	3.3	69.4	21.0	6.1	6.9	< .01	SSR > U
DCN	Glove	51.6	21.6	6.2	48.4	21.8	6.3	45.3	15.8	4.6	0.3	n.s	n.s.
	Glasses	82.5	20.0	5.8	80.5	21.1	6.1	71.0	25.0	7.2	1.4	n.s	n.s.
MO	Glove	5.4	5.4	1.6	64.4	26.1	7.5	48.7	29.2	8.4	32.1	< 0001	SSR > U; PU > U
	Glasses	23.1	15.3	4.4	62.8	19.9	5.7	55.3	19.2	5.6	17.5	< 0001	SSR > U; PU > U
OT	Glove	62.1	18.9	5.5	95.4	5.8	1.7	54.5	23.6	6.8	25.5	<.0001	SSR > U
	Glasses	63.8	20.9	6.0	75.6	18.1	5.2	68.0	21.5	6.2	2.7	n.s	n.s.
Grnd Mn	Glove	43.5			71.9			45.5					
	Glasses	51.2			72.6			61.0					

Table 2. Two of the three cases in which listener ratings were significant for an aided-practice effect (Post-U > U), as well as an aided effect (SSR > U). The transcripts are presented here in full and unpunctuated. Underlined text conveys themes and content in the Post-U sample that suggest carry-over from the aided production.

EC (Broken Glasses)

Lead-in: You are at the optician's shop. You brought these in (present broken glasses). I am the sales person. What do you say?"

U (Mn rating 12.6): I lost the I lost the I don't know where it is I don't know where it is uh the uh the eyeglasses I lost it mmhmm I lost it no uh another pair a new pair a new pair

SSR (Mn rating 52.7): hello I got a problem I lost the eyeglasses I can't find them I lost them I want you to fix it I will pick it up later today how much is it cost fifty dollars fine the American Express so long

Post-U (Mn rating 41.3): I lost the the uh I lost the uh I can't find it the the I lost it I lost it and uh um another pair or uh another pair or fix it fix it uh how much is it how much is it um oh okay alright then I uh come back later come back later in the in the evening and I get the money now I get the money now and how how much is it cost okay the check write a check yeah write a check

MO (Lost Glove)

Lead-in: You are in the drugstore and this (present glove) is lying on the floor. You take it to the counter. What do you say?

U (Mn rating 5.4): Um /st•z/ [excuse] me um uh we have uh uh /pw¶bw¶m/ [problem] /wfls/ uh uh um /s°wi/ [sorry] we uh I /h-/ (long pause) um /t-/ I I'm um I'm I know I'm trying um um uh /h-/ /h-/ /s-/ /s°wi/ [sorry] but um I /pIfik/ [think] you /h-/ eh /b¶-/ /hfln/ uh /kflnt‡r/ /n°/ [no] that's I'm I'm I'm sorry /bflt/ /b°/ /i/ got I /g-/ I can't the words

SSR (Mn rating 64.4): /d•z/ [excuse] me the /gov/ [glove] sitting on the /for/ [floor] I don't know who belongs to I'll will /fᵃs/ [lost] and found I don't know but maybe /d•/ [you] can /pfaIn/ /dIt/ [find it] goodbye

Post-U (Mn rating 48.7): okay 'scuse me um I have a /gr¶v/ [glove] is /fᵃnd‡d/ on the /for/ [floor] I don't know what it's /st•z/ to but you can /wᵃst/ [lost] and find I guess okay I are you but nobody know this is /t•z/ to is the the /fᵃnt-/ I don't know this this the /fᵃs/ to ah man well I'll /wᵃst/ [lost] and found okay I'll see you

U, Unaided; SSR, created on the SentenceShaper; Post-U, post-SSR-unaided. Bracketed text shows authors' gloss of apraxic utterances.