Combined Aphasia and Apraxia of Speech Treatment (CAAST): Effects of a Novel Therapy Approach

Acquired apraxia of speech (AOS) is a neurologic motor speech disorder that is characterized by slow rate of speech, difficulties in sound production, and disrupted prosody (McNeil, Robin, & Schmidt, 2009). AOS is typically accompanied by aphasia and occurs rarely in its "pure" form, without aphasia (Duffy, 2005). Duffy reported that 22% of stroke survivors, who were diagnosed with aphasia as their primary communication disorder, also had AOS (Duffy, 2007). The relative contributions of aphasia and AOS to overall communication disruption in persons with both disorders are not well understood. Although many persons with aphasia and AOS likely require treatment for both disorders, there has been limited research addressing treatments that have been designed to target these disorders simultaneously.

None of the AOS treatments described in the AOS treatment guidelines included direct treatment for language (Wambaugh et al., 2006). Recently, Youmans, Youmans, and Hancock (2011) modified script training to include feedback for sound production accuracy and articulatory placement; positive findings were reported for three participants with AOS and aphasia. Response Elaboration Training (RET; Kearns, 1985) was modified for persons with aphasia and AOS (Wambaugh & Martinez, 2000; Wambaugh et al., 2012), but did not include specific treatment for apraxic speech production errors. In the current investigation, modified-RET (M-RET) was combined with an established AOS treatment, Sound Production Treatment (SPT, Wambaugh, Kalinyak-Fliszar, West, & Doyle, 1998) to improve language and speech production. The purpose of the current investigation was to examine the effects of this novel treatment with three speakers with aphasia and AOS.

Method

Participants

Three men with chronic aphasia and apraxia of speech served as participants. They were between 12 and 65 months post-onset of a single, left-hemisphere stroke. All were native-English speakers, passed a hearing screening, had completed high school, and were home-dwelling (see Table 1). The participants did not receive any other speech/language treatment during the study.

As shown in Table 2, the participants' Porch Index of Communicative Ability (PICA; Porch, 2001) overall percentile scores ranged from the 47^{th} to the 58^{th}. All demonstrated significant word-retrieval difficulties on the Test of Adolescent-Adult Word-Finding (German, 1990). Participants 2 and 3 received a diagnosis of Broca's aphasia according to Western Aphasia Battery-R criteria (WAB-R; Kertesz, 2007). Their productive language was agrammatic and typically consisted of single words or short phrases with a predominance of nouns. Participant 1 received a diagnosis of anomic aphasia based upon WAB-R performance. His verbal productions in discourse were primarily short sentences and phrases that were mildly agrammatic.

All participants demonstrated speech characteristics that were consistent with a diagnosis of AOS (McNeil, Robin, & Schmidt, 2009). They exhibited slow rate of speech, sound errors that were relatively consistent in terms of location and type of error, error types that were often distortions, and prosodic disruptions.

Experimental Design

Multiple baseline designs across behaviors and participants were used to examine the effects of treatment on the production of correct information units (CIUs; Nicholas & Brookshire, 1993). CIUs were elicited in narrative discourse produced in response to experimental picture sets in probes repeatedly prior to treatment. The number of baseline probes was extended across participants.

Following the baseline phase, treatment was applied sequentially to sets of experimental pictures. During the treatment phases, probes were continued to measure performance with trained and untrained behaviors. Probes were conducted following every two treatment sessions for the set under treatment (probes always preceded the next day's treatment session). Probes for sets not receiving treatment were completed at the end of each treatment phase. Additional probing for the second set designated for treatment was conducted prior to treatment application. Follow up probes will be conducted at 2 and 4 weeks following completion of treatment.

Experimental Stimuli/Probe Procedures

Narrative discourse stimuli. Three sets of 10 line drawings depicting actions were used to elicit samples of narrative discourse in probes. The examiner presented each picture with the following instructions: "Tell me as much as you can about this picture. You can talk about the picture or anything it reminds you of." The pictures in each set were presented in random order with order of sets randomized. The participants were allowed as much time as needed to respond.

Two of the sets of pictures were used in treatment (applied sequentially) and the third set remained untreated. Consequently, responses to the treated picture sets in probes reflected *acquisition effects* of treatment and responses to the untreated set(s) represented *response generalization effects* of treatment.

Speech production stimuli. Two sets of 10 sentences each were developed to elicit speech samples for measuring articulatory accuracy. The sentences contained words that were predicted to be similar to those produced in the narrative discourse samples. Each sentence was canonical in structure and 7-9 syllables in length (e.g., "The boy is riding a bike.") The sentences were presented verbally, one at a time, and the participant was asked to repeat the sentence as accurately as possible. For one set, printed stimuli were presented along with the verbal model in order to counter possible word-retrieval difficulties.

Dependent Variables

CIUs. All probe narrative discourse samples were orthographically transcribed by the examiner using on-line transcriptions supplemented by audio recordings. All transcriptions were independently verified with corrections made as necessary. Number of CIUs was calculated for each discourse sample following procedures described by Nicholas and Brookshire (1993). Total number of CIUs was tabulated for each experimental set.

Percent Consonants Correct. For each target sentence, the number of consonants articulated correctly in content words was determined using audio recordings. Percent correct consonants (PCC) for each set of sentences was calculated.

Treatment

Treatment combined M-RET (Wambaugh et al., 2012) and SPT (Wambaugh et al., 1998). In addition, an aspect of mapping therapy was incorporated into the M-RET portion of treatment. A complete treatment description is presented in the Appendix.

Treatment was administered by an ASHA certified speech-language pathologist (or CFY fellow) three times per week in each participant's home or clinic. Sessions were approximately 60 minutes in length. Treatment was applied for a maximum of 20 treatment sessions per phase or until performance plateaued on probes.

Results

The number of CIUs in probes is displayed in Figures 1-3 for Participants 1-3, respectively. The first phase of treatment has been completed for all participants and the second treatment phase is underway for Participants 1 and 2. Participant 3 is completing extended probing prior to application of treatment with the second set.

As seen in the figures, CIU production increased with application of treatment for all participants. Effect sizes were calculated using all baseline probe values and the final three treatment phase probe values. d-Index values were as follows: Participant 1 – 15.3, Participant 2 – 3.7, and Participant 3 – 2.1.

PCC data are shown in Table 3.

Please note that although replication *within* participants has not yet been completed, experimental control has been demonstrated through the use of the multiple baseline design across participants; behavioral change occurred with application of treatment for all participants following increasing numbers of baselines.

Discussion

Results will be discussed relative to finding from previous RET, SPT, and modified script training investigations. Discussion will also address implications for clinical application and directions for future study.

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Table 1

Participant Characteristics

Participant	Gender	Etiology	CVA Location/ Type	Age	Months Post Onset of Stroke	Years of Education	Premorbid Handiness	Race/ Ethnicity	Hemiparesis
P1	Male	CVA	L MCA Ischemic	72	12	11+	R	White	none
P2	Male	CVA	L MCA ischemic	71	65	20	R	White	R UE R LE
P3	Male	CVA	L MCA Hemorrhagic	36	23	11	R	White	R UE R LE

Note: MCA = middle cerebral artery; R = right; UE = upper extremity; LE = lower extremity

Table 2

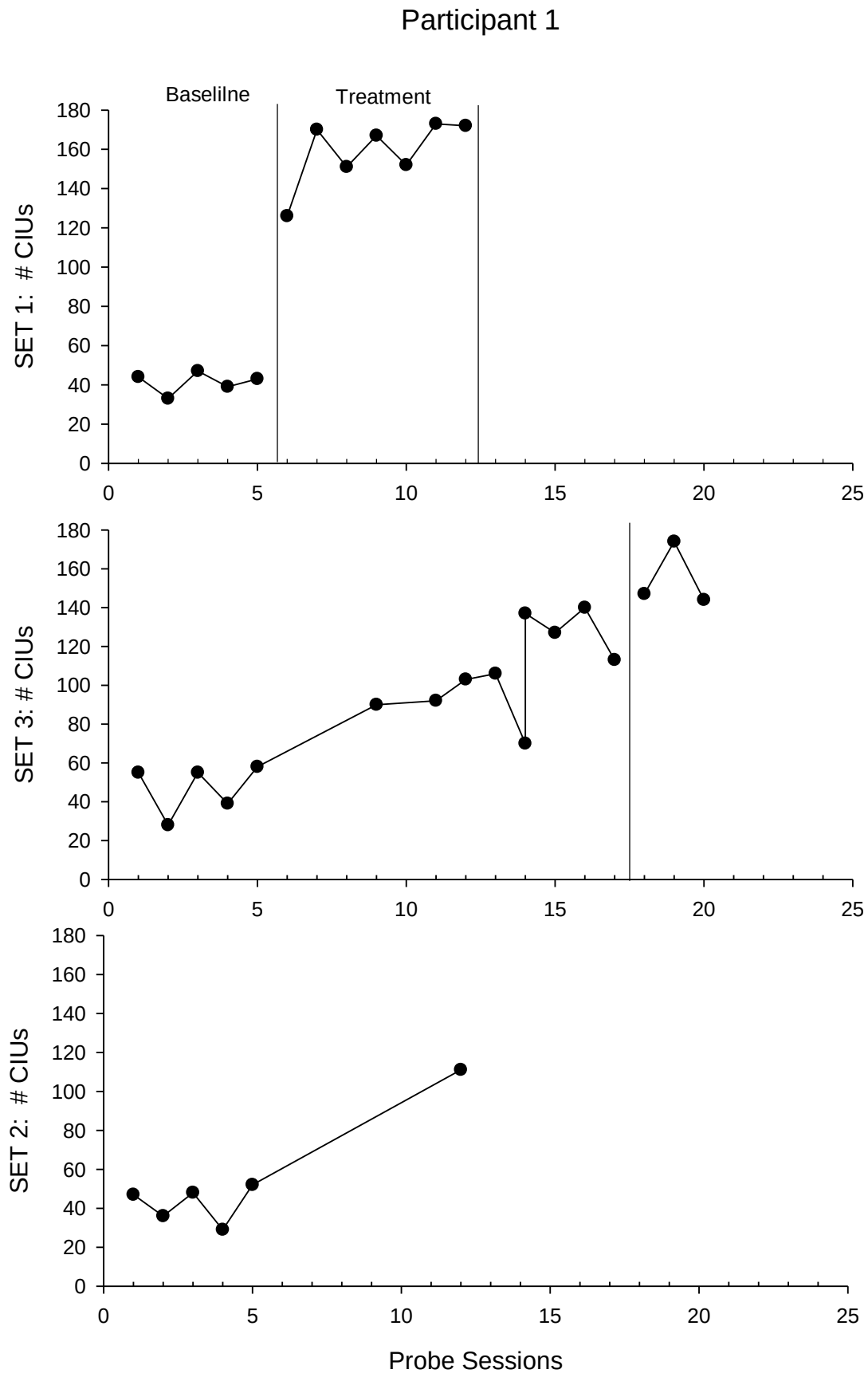
Pre treatment Assessment Results

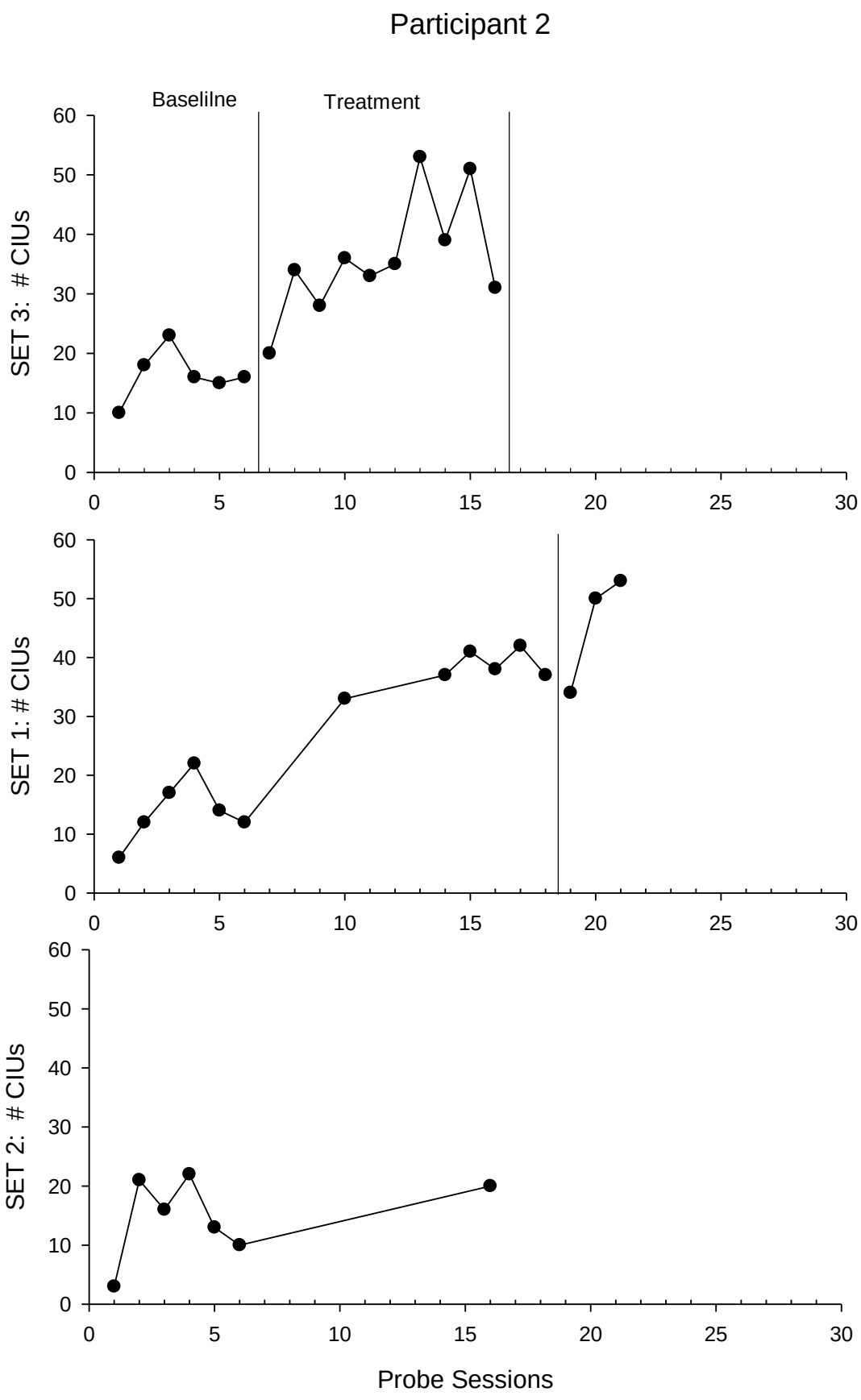
Measure	Participant 1	Participant 2	Participant 3
Western Aphasia Battery			
AQ	77.1	20.3	56
Type	Anomic	Broca's	Broca's
Porch Index of Communicative Ability			
Overall Percentile	58	47	49
Verbal Percentile	59	17	51
Auditory Percentile	54	43	40
Test of Adolescent/Adult Word Finding			
Total Raw Score	55/107	0/107	44/107
% Comprehension	95%	93%	93%
Verb & Sentence Test			
Sentence Construction	6/20	0/20	0/20
Sentence Anagram w/ Pictures	9/20	10/20	8/20
Sentence Anagram w/o Picture	12/20	16/20	8/20
Assessment of Intelligibility of Dysarthric Speech (word level – orthographic transcription)	70%	4%	70%
Test of Nonverbal Intelligence – 4			
Percentile	34th	42nd	19th
Nicholas & Brookshire (1993)			
Correct Information Units – Total	279	12	129
Correct Information Units/Minute	20.4	1.2	7.46
Estimated AOS Severity	Mild-moderate	Severe	Moderate

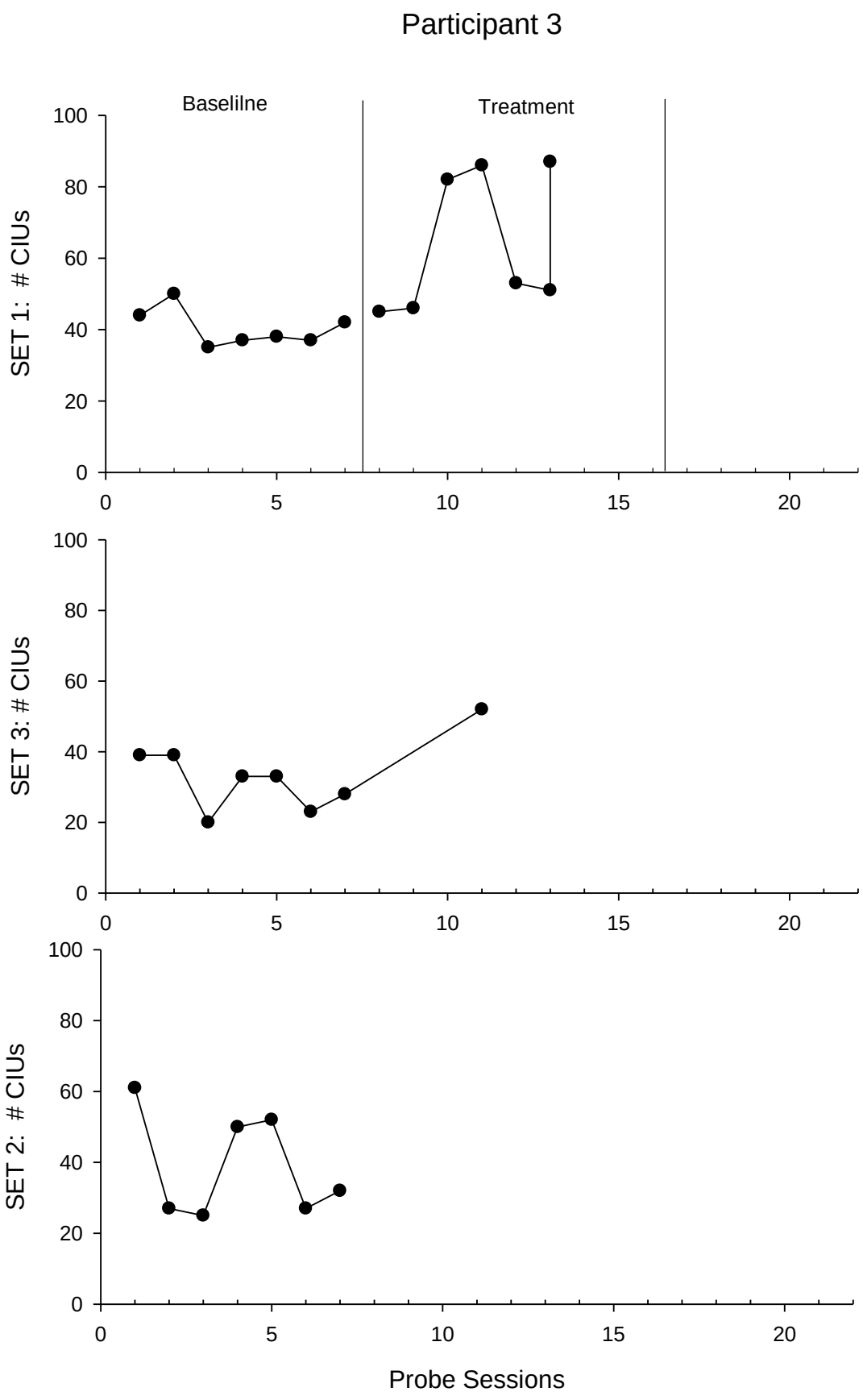
Table 3

Percent Consonants Correct in Sentences

Participant	PCC	BL1	BL2	BL3	Mid tx 1	Post tx 1
P1	Without written stimuli	87%	89%	89%	91%	92%
	With writtenstimuli	88%	90%	92%	90%	92%
P2	Without written stimuli	3%	14%	3%	13%	24%
	With writtenstimuli	20%	21%	11%	32%	26%
P3	Without written stimuli	45%	48%	44%	58%	
	With writtenstimuli	68%	71%	48%	55%	


Participant 1
Baselilne
Treatment
SET 1: # CIUs
SET 3: # CIUs
SET 2: # CIUs
0
20
40
60
80
100
120
140
160
180
0
5
10
15
20
25
Probe Sessions


Participant 2
Baselilne
Treatment
SET 3: # CIUs
SET 1: # CIUs
SET 2: # CIUs
0
10
20
30
40
50
60
0
5
10
15
20
25
30
Probe Sessions


Participant 3
Baselilne
Treatment
SET 1: # CIUs
SET 3: # CIUs
SET 2: # CIUs
0
20
40
60
80
100
0
5
10
15
20
Probe Sessions

Appendix: Combined Aphasia and Apraxia of Speech Treatment (CAAST)

Introduction: Show sentence frame. "We are going to practice saying short sentences. Most sentences are made up of these parts (point to frame)…
a "doer" – someone or something that does something
an "action" – what is being done
and a "theme" – a person, place or thing that is involved with what is being done
"other" – we have a space for "other" parts of sentences so that we can include descriptor words – like "big", "pretty", "hard", "hot"

DOER	ACTION	THEME	OTHER

Step 1. Present a picture (random order) with a prompt (e.g. "Tell me about this picture", "What does this remind you of?", "Tell me what's happening.").

A. Upon an appropriate response (any utterance related to the picture), go to Step 2
B. Upon an inappropriate or no response, verbally provide two response examples and request a response (e.g. "You could say something like *noun phrase* [hairy man] or *verb phrase* [shaves face]."; "You could say something like *noun* + *verb* [man shaves] or *verb phrase* [shaves beard]).

1) Upon an appropriate response, go to Step 2.
2) Upon an inappropriate or no response, provide a one word model and request a repetition (e.g., "Say *noun* [man]." or "Say *verb* [shaves]."

a. Upon an appropriate response, go to Step 2.
b. Upon an inappropriate or no response, use integral stimulation with a maximum of four attempts to elicit the noun or verb production (e.g., "Watch me, listen to me, say it with me…man"). Upon an appropriate response, go to Step 2. Upon an inappropriate or no response, present the next item.

Step 2. Repeat the participant's production and reinforce it. (e.g., "Man…good"). Refer to sentence frame and write the participant's response under the correct part of the frame. (e.g., "man" can be the doer or the theme…where shall we put it?). If no direction from patient or an incorrect response, print the response under an appropriate item. Go to Step 3.

Step 3. Ask a question to elicit another element of the frame (e.g., "what is the man doing?"

A. Upon an appropriate response, go to Step 4.
B. Upon an inappropriate or no response, model two response examples and request a response (e.g. "You could say something like noun phrase [foamy face] or verb phrase [shaves beard].")

1) Upon an appropriate response, go to Step 4.
2) Upon an inappropriate or no response, provide a one word model and request a repetition (e.g., "Say *noun* [beard]." or "Say *verb* [shaves]."

a. Upon an appropriate response, go to Step 4.
b. Upon an inappropriate or no response, use integral stimulation with a maximum of four attempts to elicit the noun or verb production (e.g., "Watch me, listen to me, say it with me…shaves"). Upon an appropriate response, go to Step 4. Upon an inappropriate or no response, present the next item.

Step 4. Reinforce the participant's production from Step 3, print the response in the frame, and model a phrase/sentence that combines the participant's productions from Steps 1 and 3 (e.g. `Right, shaves. Man shaves.") Go to Step 5.

Step 5. Model the combined production again and request a repetition.

A. Upon a correct response (all target words produced with correct articulation), request three repetitions of the utterance using integral stimulation as needed. Go to Step 6.* (use in subsequent substeps when a correct production occurs)
B. Upon an incorrect or no response, underline sounds in error on frame (up to 3 sounds). Say…"let's think about these sounds and try again". Model sentence and request a response. If correct…3 reps – Step 6*
C. If incorrect, give feedback and say let's try again….use integral stimulation up to 3X for each target sound in each word. Say let's try the entire phrase again and request 3 reps with integral stimulation as needed. Proceed to step 6.
D. If incorrect give articulatory placement for all sounds in error (up to 3 sounds) while referring to frame; try entire phrase again with integral stimulation for 3 repetitions. If correct…..*If incorrect, give feedback on target sounds and go to Step 6.

**E.g. response is "man sabs": This sound (point/underline to sh) in shaves is a little off. Try putting your teeth together…..and try the word "shaves". Give feedback as appropriate. Now this sound (v) is also not quite right. Try….. and try the word "shaves". Give feedback as appropriate. Now…let's try those sounds again in the whole phrase "man shaves" with integral stim.

Step 6. Remove the picture, wait for approximately five seconds, return the picture and request that the participant again describe the picture.

A.Correct or alternate correct response, reinforce and go to the next picture.
B.Parially correct response—assist with integral stimulation
C.No response—model and request repetion using integral stimulation

***If time allows*, conduct ADDITIONAL SPT** - after completing all pictures, repeat Step 5 with sentences/phrases written previously.