Multi-modality aphasia therapy is as efficacious as constraint induced aphasia therapy for chronic aphasia: A phase 1 study

Introduction

Constraint-induced aphasia therapy (CIAT; Pulvermüller et al., 2001) has been shown to be efficacious in promoting positive changes in formal tests of language function and client perceptions of everyday communication for many individuals with chronic aphasia. Since the publication of the CIAT studies, questions have arisen concerning the appropriateness of utilizing well-established multi-modality treatments in aphasia rehabilitation (Rose, in press). Multi-modal treatments exploit the often-preserved drawing, gesture, reading and writing abilities of individuals with aphasia, either as compensation techniques when spoken communication fails to be restored, or as direct cross-modal facilitation techniques to reestablish language and speech. Multi-Modality Aphasia Treatment (M-MAT; Attard, Rose & Lanyon, 2013) is one such treatment. What remains unclear is the relative efficacy of these two intensive but fundamentally different treatment types (CIAT and M-MAT). Such information is necessary to minimize unnecessary health care spending.

Aims and hypotheses

Primary Aim: To compare the efficacy of M-MAT to CIATplus for individuals with chronic aphasia. Based on the small amount of available pilot data *we hypothesized* that CIATplus and M-MAT would be equally efficacious in improving picture-naming abilities and reducing aphasia severity immediately following treatment and at 1-month follow-up. The secondary aim was to explore participant variables impacting potential differential responsiveness to treatment. The latter aim was exploratory and not hypothesis-driven.

Method

Participants

Eleven participants were recruited. Inclusion and exclusion criteria included: single left hemisphere stroke at least 12 months prior to the study; aphasia without severe apraxia of speech, motor speech disorder, or severe limb apraxia; no history of other neurological disorder, uncorrected vision or hearing loss, or substance abuse; not currently receiving speech-language pathology services; right handed pre-morbidly; and English as first and primary language. Demographic details are provided in Table 1. Five females and six males participated, ranging from 17 to 88 months post onset. There were four individuals with mild, six with moderate, and one with severe aphasia.

Research design

We utilized 11 single-subject multiple-baseline designs with a cross over for treatment order. Six participants (RW, SS, BH, LV, JP, PK) received M-MAT first followed by CIATplus, while five participants (JB, ST, LM, AC, PD) received CIATplus first. Intensity of treatment was constant across both treatments: 3.25 hours per day/4 days per week/2 weeks + 45 minutes of refreshment breaks each day (32 hours contact for each treatment type; 64 hours total). One week separated the two treatment phases. Assessments were carried out before treatment (pre-treatment assessment—see results in Table 2), after the first 2-week treatment block (mid-assessment), after the second two-week treatment block (post-assessment), and at one-

month and three-months after treatment completion (follow ups). Three separate groups of participants undertook the study over a 6-month period (Group 1—5 participants, Group 2—3 participants, Group 3—3 participants). Group 1 broke into two smaller groups (2 and 3 people) for at least 1 treatment hour per day.

Stimuli

Treatment stimuli were black and white line drawings of nouns and verbs from the Object and Action Naming Battery (Druks & Masterson, 2000), the Snodgrass and Vanderwart pictures (Snodgrass & Vanderwart, 1980), and the International Picture-Naming Project (Szekely et al., 2004). Of these items, 80 (40 nouns and 40 verbs) were trained in CIATplus and 80 (40 nouns and 40 verbs) in M-MAT, with 20 items (10 nouns and 10 verbs) serving as untreated controls. Eight different categories of nouns were utilized: four in CIATplus and four in M-MAT. One-, 2-, and 3-place (argument) verbs were balanced across the two treatment phases.

Probing

Probing of the entire corpus took place at each phase: three probes at pre-treatment, post CIATplus, and post M-MAT; and one probe at each of the one and three-month follow ups. In addition, probing of the target stimuli (160 items) took place at the beginning of every second treatment session (80 items were probed on each occasion, so that the entire treated set (160 items) was probed twice across each treatment phase).

Procedure

The procedures adopted for this trial replicated those of a recent pilot study (Attard, Rose, & Lanyon, 2013). M-MAT is a manualized treatment protocol (Rose & Attard, 2011) with the primary treatment objective to facilitate spoken naming rather than multi-modality communication. Thus, naming is practiced along with the addition of gesture, drawing, reading, and written naming cues. CIATplus was carried out as described by Meinzer and colleagues (2005) and focuses on naming without multi-modal cues.

Data analysis

Standard case charts were developed for visual analysis of each participant's probe results across all phases of the study. Effect sizes were calculated on naming probe scores using Busk and Serlin's (1992) *d* and a classification of the magnitude of effect size was made with Beeson and Robey's (2006) suggestions of small (2.6), medium (3.9), and large (5.8) effects for aphasia therapy.

Reliability and Treatment Fidelity

Inter- and intra-rater reliability was investigated on 20% of the video-recorded probe data results. A speech-language pathologist not involved in providing the therapy reviewed 10% of video-recordings/live sessions (viewed behind a one-way mirror) that were randomly selected and indicated whether the treatment protocols were being followed.

Results

Point-to-point inter- and intra-rater reliability results will be available in March 2013. Treatment fidelity was reported to be 100% accurate. Figures 1-11 display the

individual probe results. Tables 2 and 3 show the results of standardized tests, and effect sizes for probes across all phases of the study.

Primary outcome measure: Noun and Verb Probes

As expected with this heterogenous group of participants, variable effect sizes were demonstrated across noun and verb probes. Of a total 44, 31 effect sizes reached small (2), medium (9), or large (20) levels. Overall, higher effect sizes were found for nouns and for items treated during the first treatment phase, irrespective of the treatment type.

Secondary outcome measure: Western Aphasia Battery Aphasia Quotient (WAB AQ)

All participants demonstrated improvement on the WAB AQ on at least one time point. A recent Rasch analysis has suggested variable standard error of measurement for WAB AQ according to aphasia severity ranging from <2 points (AQs 30-70) to >6 (AQ <20; AQ >90) (Hula et al., 2010). In this study, we chose a somewhat conservative AQ change score of 3 points overall and/or a 1 point change on either the fluency or information rating score (Spontaneous Speech section) to reflect treatment responsiveness (see bold text Table 2). Using these criteria, all participants responded to the treatments.

A comparison of WAB AQ immediately following M-MAT as compared to immediately following CIATplus revealed four participants favored M-MAT (> 2 point WAB AQ difference between M-MAT and CIATplus) and five participants favored CIATplus. Order effects are likely to have played a significant role: seven participants achieved greater WAB AQ change scores following the first treatment than following the second treatment phase (compared to mid-phase scores).

Discussion

This well-controlled, phase one study directly compared M-MAT and CIATplus, two intensive but fundamentally different treatments with opposing rationales: constraint versus multi-modal support. Results suggest they are equally efficacious, though order effects may have masked clear differences. Discussion will center upon the participant variables associated with the best response to treatment, the need for large-scale randomized studies comparing these two treatments, and the likely mechanisms underpinning multi-modal treatment response in chronic aphasia.

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Table 1. Participant Characteristics

Participant	Age	Gender	Education (years)	Stroke Type/ Lesion side	MPO	Pre WAB AQ	Limb apraxia	Apraxia of Speech	Hemiparesis	Handedness
RW	49	F	15	Left ischemic	77	92.8	Absent	Absent	Right	Right
SS	59	F	16	Left (type na)	25	91.24	Absent	Mild	None	Right
LV	69	M	15	Left (type na)	34	85.6	None	Mild-Moderate	None	Right
JP	64	F	13	Left hemorrhagic	22	77.2	Moderate	Very Mild	Right	Right
BH	39	M	15	Left ischemic	88	63.8	Mild	Mild	Right	Right
ST	46	M	16	Left SAH	22	61.5	Mild	Mild-Moderate	Right	Right
AC	64	F	17	Left (type na)	40	57.4	Mild	Severe	None	Right
JB	53	M	15	Left ischemic	17	56.8	Mild-Moderate	Mild-Moderate	Right	Right
LM	74	F	15	Left ischemic	79	51.9	Moderate	Moderate	None	Right
PD	56	M	19	Left ischemic	22	50.6	Moderate	Mild	Right	Right
PK	66	M	10	Left ischemic	58	36.2	None	Moderate-Severe	None	Right

Note: MPO: months post-onset; (type na): type not available

Table 2a. Results of baseline language and cognitive testing, and at immediate post each treatment, and 1 and 3 month follow up points (BH, RW, SS)

Assessment	BH					RW					SS				
	Pre Tx	Post M	Post C+	1 Mo.	3 Mo.	Pre Tx	Post M	Post C+	1 Mo.	3 Mo.	Pre Tx	Post M	Post C+	1 Mo.	3 Mo.
Western Aphasia Battery—Revised (Kertesz, 2007):															
Aphasia Quotient	63.8	66.2	**72.3**	**79.7**	**67.1**	92.8	91.9	**96.1**	**97.6**	**96.8**	91.2	**95.2**	92.2	**94.7**	94.1
Spontaneous Speech:															
Information Content /10	5	5	**7**	**9**	**8**	9	8	**10**	**10**	**10**	10	10	10	10	10
Fluency /10	5	**6**	**6**	**6**	**6**	9	9	9	9	9	9	9	9	9	9
Auditory Verbal Comprehension:															
(Total score /10)	8.3	8.0	7.6	8.85	8.05	10	9.7	10	10	10	9.2	9.3	9.2	9.75	9.75
Repetition (Total score /10)	6.1	7.3	7.2	7.6	7.0	10	9.4	9.1	10	10	8.6	9.3	8.6	9.3	9.2
Naming and Word Finding:															
(Total score /10)	7.5	6.8	7.2	8.4	7.1	8.4	9.4	9.1	9.8	9.4	8.9	9.3	9.3	9.3	9.1
Object Naming /60	49	44	49	53	42	57	59	58	60	58	57	59	56	60	58
Word Fluency /20	8	12	11	16	15	7	15	13	18	16	16	14	17	13	15

Sentence Completion /10	10	8	10	8	7	10	10	10	10	10	9	10	10	10	10
Responsive Speech /10	8	4	2	7	7	10	10	10	10	10	7	10	10	10	8
Boston Naming Test (Goodglass et al., 2001) /60	21	27	42	38	33	44	59	53	55	57	51	56	53	52	50
Scenario Test (van der Meulen et al., 2010) /54	32	41	44			54	54	54			54	54	53		
Communicative Effectiveness Index (CETI; Lomas et al., 1989) /100	79	87	86			60	60	73			68	NA	78		
Stroke and Aphasia Quality Of Life Scale (SAQOL; Hilari & Byng, 2001)															
Communication	2.57		3.43			3.14		3.71			4		4.14		
Psychosocial	5		5			3.1		3.91			5		4.55		
Pyramids and Palm Trees **(**Howard & Patterson, 1992) /52	47					50					51				
Coloured Progressive Matrices (Raven, Court, & Raven, 1995) /36	35					32					31				

Rey-Osterrieth Complex Figure Test (as cited in Fastenau et al., 1999)						
Copy/36	36		33		35	
Recall /36	29.5		13		21	

Note: Pre Tx = Pre treatment; Post M = Post-M-MAT; Post C+ = Post CIATplus; 1 Mo. = 1 month follow-up; 3 Mo. = 3 month follow-up.
Bold figures: treatment responsiveness (see text)

Table 2b. Results of language and cognitive testing at baseline, and at immediate post each treatment, and 1 and 3 month follow up points (LV, PK, JP)

Assessment	LV					PK					JP				
	Pre Tx	Post M	Post C+	1 Mo.	3 Mo.	Pre Tx	Post M	Post C+	1 Mo.	3 Mo.	Pre Tx	Post M	Post C+	1 Mo.	3 Mo.
Western Aphasia Battery—Revised															
(Kertesz, 2007): Aphasia Quotient	85.6	87.6	**88.9**	**89.1**		36.2	**45.2**	**52.9**	**42.6**		77.2	**81.1**	**81.6**	**82.4**	
Spontaneous Speech															
Information Content /10	10	10	10	10		3	**5**	**7**	**5**		8	**9**	**9**	**9**	
Fluency /10	9	9	9	9		4	4	4	4		6	6	6	6	
Auditory Verbal Comprehension															
(Total /10)	8.0	9.2	8.75	8.85		5.7	7.1	8.05	7.2		8.7	8.85	9	8.9	
Repetition (Total /10)	9.3	8.9	9.4	9.4		3.2	2.7	2.8	1.2		9.2	9.8	9.8	9.8	
Naming and Word Finding															
(Total /10)	6.1	6.7	7.3	7.3		2.2	3.8	4.6	3.9		6.7	6.9	7	7.5	
Object Naming /60	42	43	50	44		12	24	27	25		46	46	42	48	
Word Fluency /20	2	6	4	9		6	5	8	5		5	7	9	7	
Sentence Completion /10	7	10	9	10		0	3	4	3		8	8	10	10	
Responsive Speech /10	10	8	10	10		4	6	7	6		8	8	9	10	
Boston Naming Test															
(Goodglass et al., 2001) /60	28	40	39	44		3	5	9	11		18	30	32	30	
Scenario Test															

(van der Meulen et al., 2010) /54	54	54	51		38	38	38		48	45	48	
Communicative Effectiveness Index (CETI; Lomas et al., 1989) /100	93	98	99	na	32	31	28	31	29	41	43	na
Stroke and Aphasia Quality Of Life Scale (SAQOL; Hilari & Byng, 2001)												
Communication	4.0	3.43	4.43		3.14	2.43	3.14		2.57	2.14	2.43	
Psychosocial	5.0	4.91	4.91		5.0	4.64	4.18		2.73	3.18	3.0	
Pyramids and Palm Trees (Howard & Patterson, 1992) /52	48				39				48			
Coloured Progressive Matrices (Raven, Court, & Raven, 1995)												
Copy /36	33				25				24			
Recall /36	18.5				7				11			

Note: Pre Tx = Pre treatment; Post M = Post-M-MAT; Post C+ = Post CIATplus; 1 Mo. = 1 month follow-up; 3 Mo. = 3 month follow-up

Table 2c. Results of baseline language and cognitive testing, and at immediate post each treatment, and 1 and 3 month follow up points (JB, ST, LM)

Assessment	JB					ST					LM				
	Pre Tx	Post C+	Post M	1 Mo.	3 Mo.	Pre Tx	Post C+	Post M	1 Mo.	3 Mo.	Pre Tx	Post C+	Post M	1 Mo.	3 Mo.
Western Aphasia Battery—Revised (Kertesz, 2007):															
Aphasia Quotient	56.8	55	53.8	**61.5**	58.70	61.5	**66**	63.8	60	61.9	51.9	**59.1**	**60.9**	**55.6**	**57.5**
Spontaneous Speech															
Information Content /10	7	5	5	7	7	6	6	**7**	5	**7**	6	**8**	**8**	**8**	**7**
Fluency /10	4	4	4	**5**	**5**	4	4	4	4	4	4	4	4	4	4
Auditory Verbal Comprehension															
(Total score /10)	7.5	7.2	6.6	6.95	6.85	7.55	8.4	7.9	8.1	7.25	4.8	8.15	7.75	5.9	7.65
Repetition (Total score /10)	5.9	5.7	4.8	6.3	5.9	5.8	6.8	5.9	5.6	5.8	4.0	4.6	5.8	5.1	4.6
Naming and Word Finding															
(Total score /10)	6.0	5.6	6.5	5.5	5.5	7.4	7.7	7.1	7.3	6.9	4	4.8	4.9	4.8	5.5
Object Naming /60	42	35	42	34	34	50	50	55	51	48	29	24	29	29	35
Word Fluency /20	6	5	7	5	7	7	9	6	4	7	1	6	8	6	6

Sentence Completion /10	5	8	8	6	8	7	10	6	8	6	4	8	6	6	6
Responsive Speech /10	7	8	8	10	6	10	8	4	10	8	6	10	6	7	8
Boston Naming Test (Goodglass et al., 2001) /60	7	9	15	11	14	27	40	31	32	38	9	14	7	10	12
Scenario Test (van der Meulen et al., 2010) /54	40	38	38			42	44	43			33	40	44		
Communicative Effectiveness Index (CETI; Lomas et al., 1989) /100	42	41	39			29	NA	62			46	46	52		
Stroke and Aphasia Quality Of Life Scale (SAQOL; Hilari & Byng, 2001)															
Communication	3		3			2.71		2.14			3.14		2.86		
Psychosocial	4		4.36			4.18		3.18			4.45		3.8		
Pyramids and Palm Trees (Howard & Patterson, 1992) /52	43					35					46				
Coloured Progressive Matrices															
Copy /36	33					36					??				
Recall /36	27.5					17					9.5				

Note: Pre Tx = Pre treatment; Post M = Post-M-MAT; Post C+ = Post CIATplus; 1 Mo. = 1 month follow-up; 3 Mo. = 3 month follow-up.

Table 2d. Results of baseline language and cognitive testing, and at immediate post each treatment, and 1 and 3 month follow up points (AC, PD)

Assessment	AC					PD				
	Pre Tx	Post C+	Post M	1 Mo.[1]	3 Mo.	Pre Tx	Post C+	Post M	1 Mo.	3 Mo.
Western Aphasia Battery—Revised (Kertesz, 2007):										
Aphasia Quotient	57.4	56.3	56.9		**62.1**	50.6	**54.2**	52.8	51.0	**53.3**
Spontaneous Speech										
Information Content /10	5	5	5		**7**	4	**6**	**5**	4	**6**
Fluency /10	6	5	5		6	3	3	**4**	3	3
Auditory Verbal Comprehension (Total score /10)	8.1	8.95	7.75		8.45	7.6	7.3	6.4	6.8	6.45
Repetition (Total score /10)	4.9	3.4	5.2		2.8	3.2	7.9	7.7	7.5	7.7
Naming and Word Finding (Total /10)	4.7	5.8	5.5		6.8	3.2	2.9	3.3	4.2	3.5
Object Naming /60	28	37	38		47	20	12	16	25	20
Word Fluency /20	7	4	3		9	2	5	3	3	4
Sentence Completion /10	4	7	7		5	6	8	6	10	7
Responsive Speech /10	8	10	7		7	4	4	8	4	4

Boston Naming Test (Goodglass et al., 2001) /60	10	9	13		18	2	4	0	1	0
Scenario Test (van der Meulen et al., 2010) /54	46	47	46			30	29	31		
Communicative Effectiveness Index (CETI; Lomas et al., 1989) /100	54	60	60			31	44	64		
Stroke and Aphasia Quality Of Life Scale (SAQOL; Hilari & Byng, 2001)										
Communication	3.43		3.29			2.86		3.86		
Psychosocial	4.55		4.09			5		4.64		
Pyramids and Palm Trees Test (3 Pictures) **(**Howard & Patterson, 1992) /52	50					42				

Coloured Progressive Matrices (Raven, Court, & Raven, 1995) Copy /36 Recall /36	36 24		36 25	

Note: Pre Tx = Pre treatment; Post M = Post-M-MAT; Post C+ = Post CIATplus; 1 Mo. = 1 month follow-up; 3 Mo. = 3 month follow-up;
[1] AC was overseas during the 1-month follow-up assessment and so this is a missing data point

Table 3: Effect sizes for each treatment phase and at 1-month follow up (M-MAT first treatment for first six participants; CIATPlus first treatment for second five participants)

	Pre Treatment to Post M-MAT		**Post M-MAT to Post CIATPlus**		**Post CIATPlus to 1 month follow up**	
	Nouns	verbs	nouns	verbs	nouns	verbs
BH	**30.6**	4.8	8.07	**13.28**	2.84	-4.04
RW	**27.71**	**4.01**	-0.87	0.29	0.44	0
SS	**4.25**	**4.58**	1.0	2.84	0	-1.0
LV	**15.97**	2.13	5.29	**5.17**	-2.39	-0.29
JP	**28.87**	6.35	1.88	**9.60**	1.06	-0.81
PK	14.33	8.37	**27.13**	**12.67**	-3.5	-1.62
	Pre Treatment to Post CIATPlus		**Post CIATPlus to Post M-MAT**		**Post M-MAT to 1 month follow up**	
	nouns	verbs	nouns	verbs	nouns	verbs
JB	**10.97**	**1.44**	0.35	0	-1.75	-1.15
ST	**21.94**	**4.58**	0.17	-0.96	-4.04	-2.89
PD	**5.02**	**6.13**	2.51	2.58	-2.31	-0.22
LM	5.44	**22**	**7.22**	5.67	1.0	-0.40
AC	1.88	**20.21**	**3.68**	11.84	4.04*	-0.41*

Note: * 3 month as one-month not available due to participant extended travel; **Bold font** indicates effect size larger than comparison score in reverse treatment phase

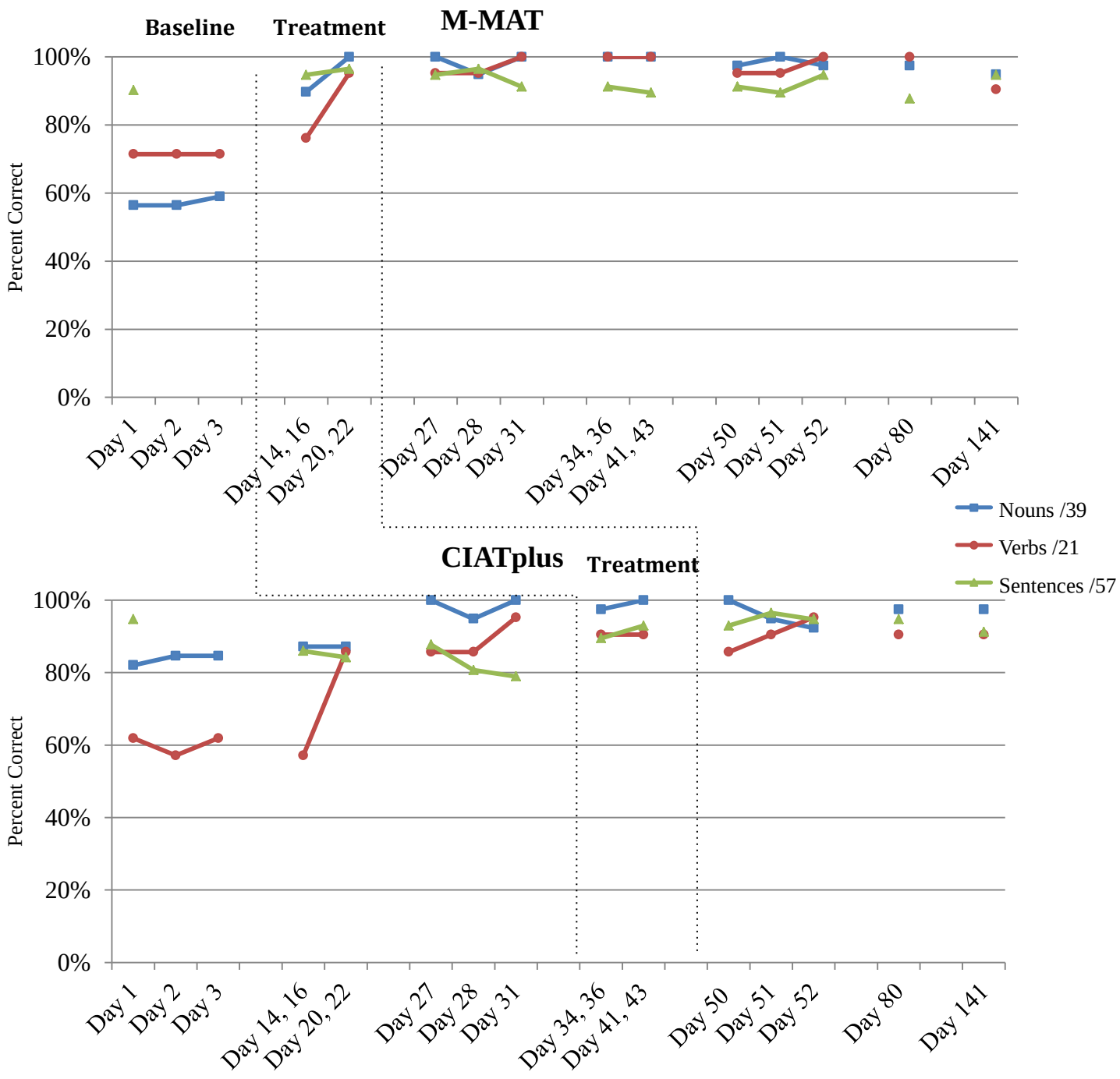

Figure 1. *Comparative Baseline, Treatment and Follow-up Probe Results for RW*

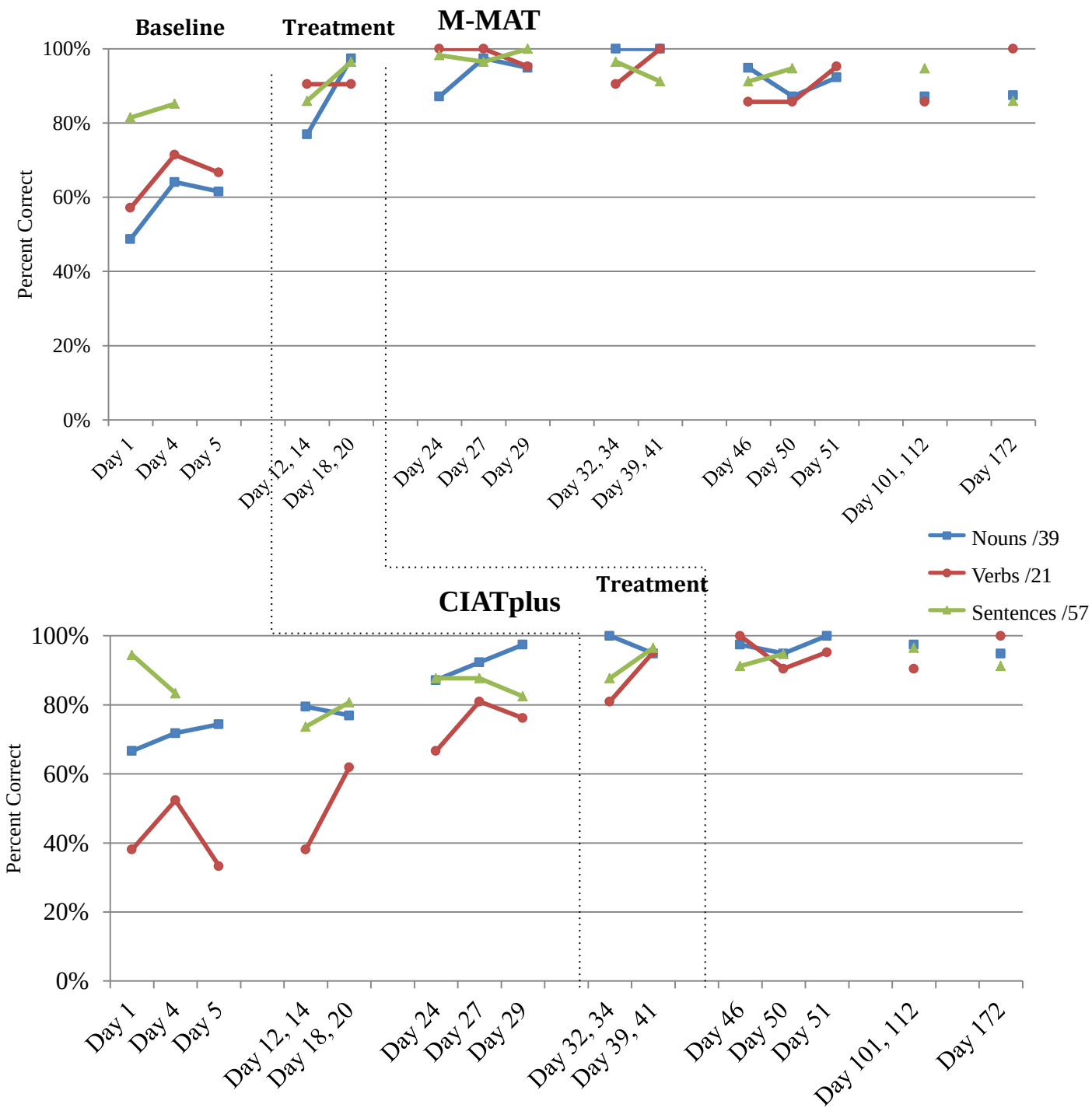

Figure 2. *Comparative Baseline, Treatment and Follow-up Probe Results for SS*

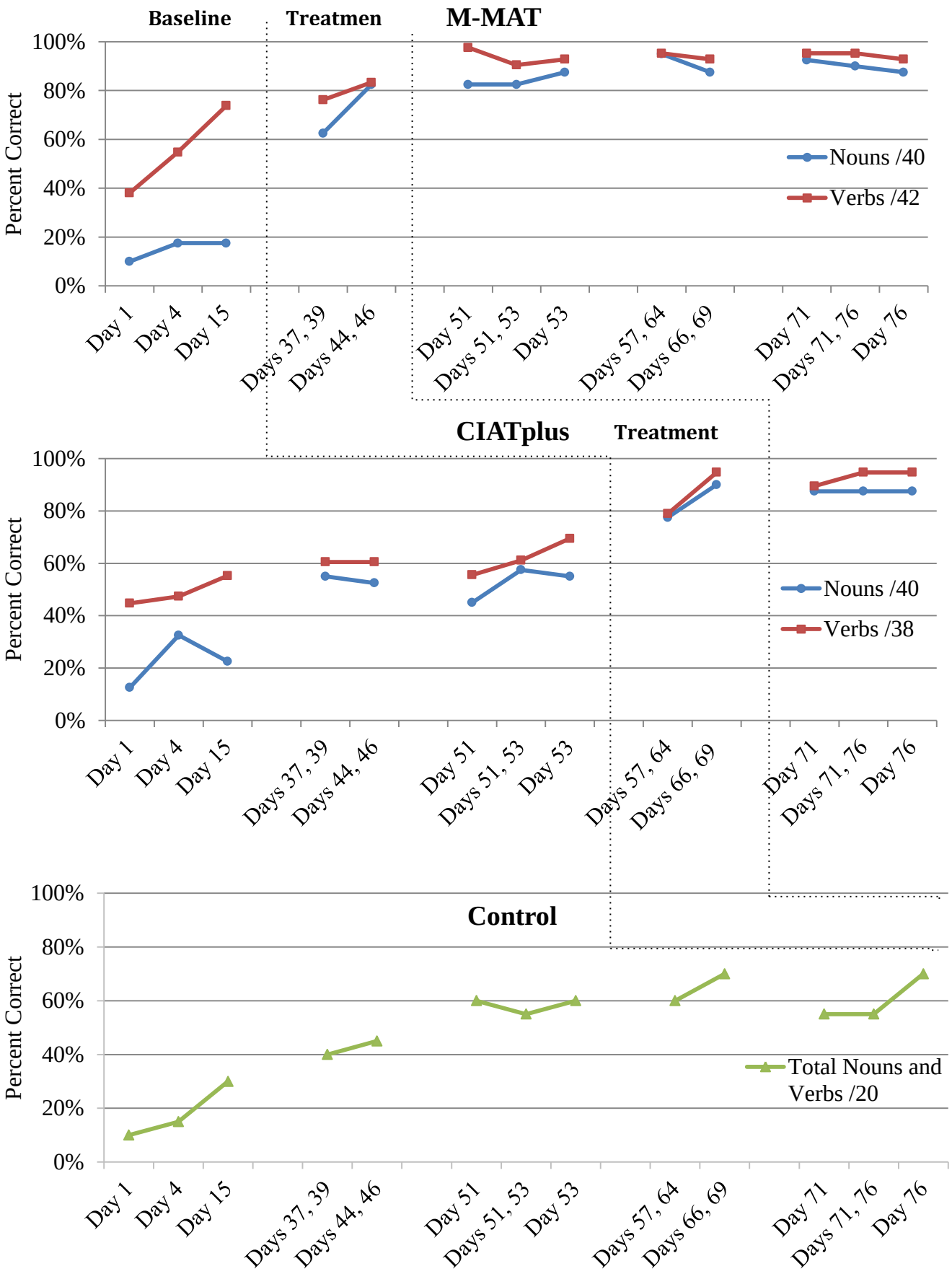

Figure 3. *Comparative Baseline, Treatment and Follow-up Probe Results for LV*

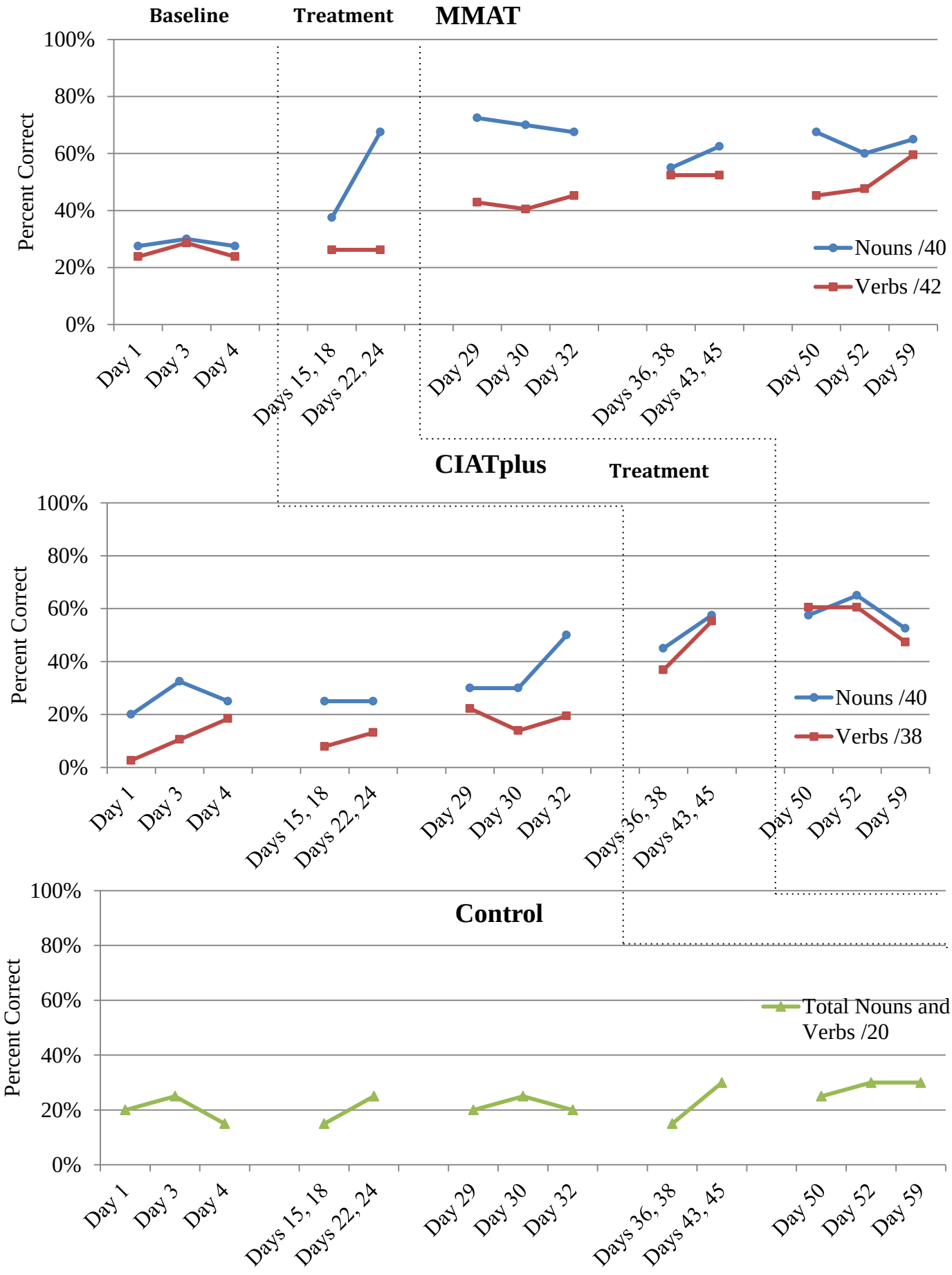

Figure 4. *Comparative Baseline, Treatment and Follow-up Probe Results for JP*

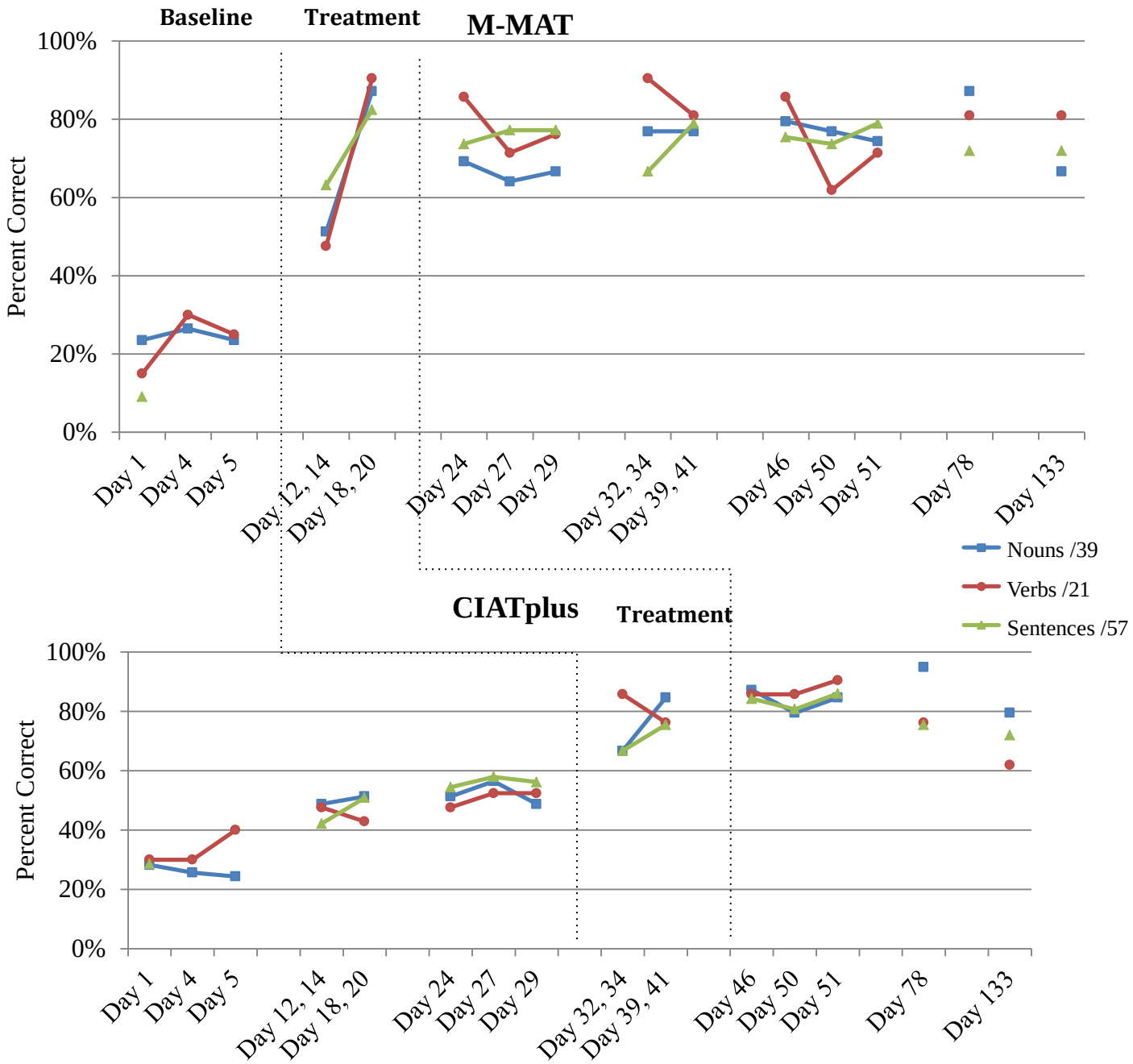

Figure 5. *Comparative Baseline, Treatment and Follow-up Probe Results for BH*

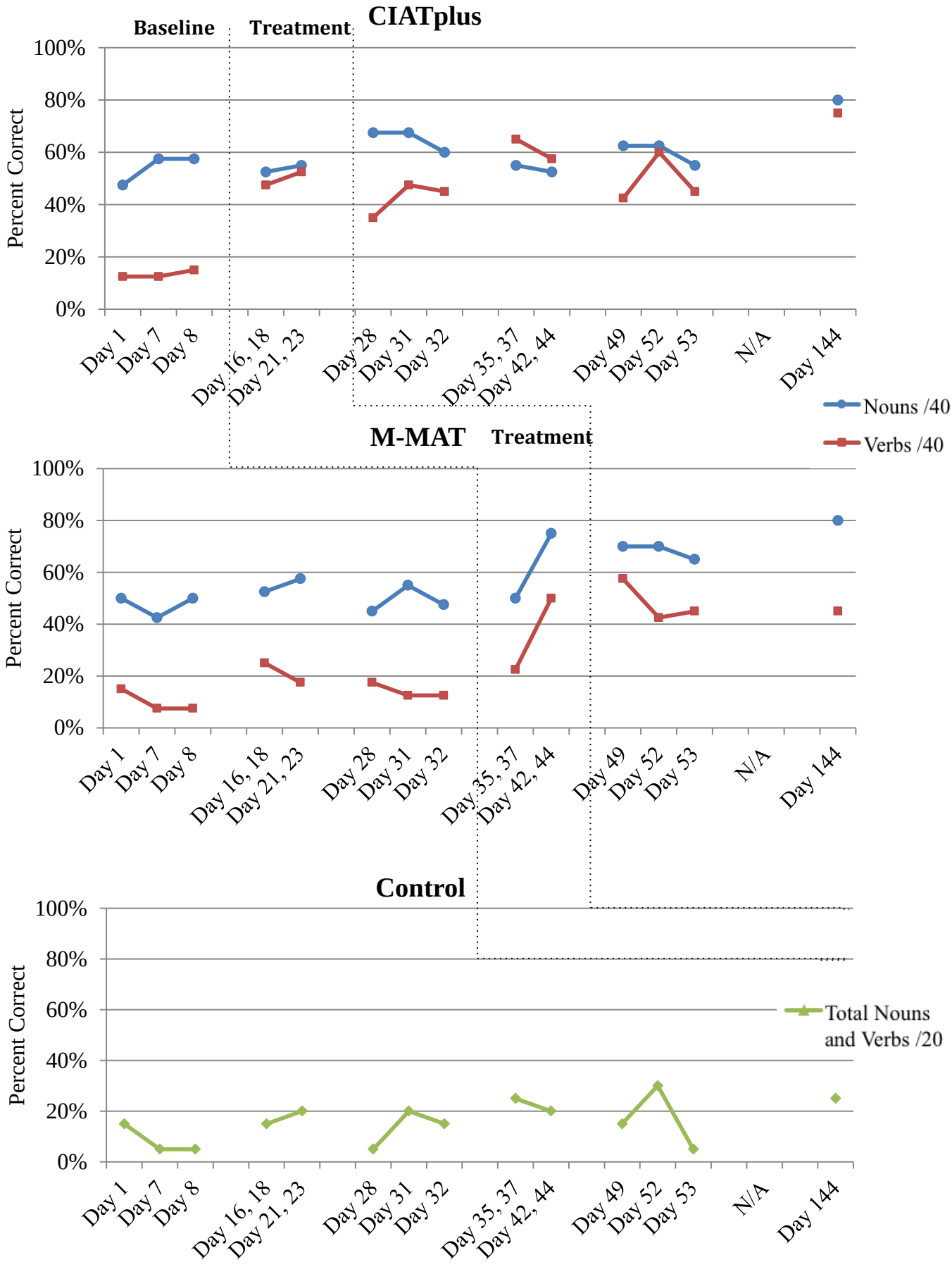

Figure 6. *Comparative Baseline, Treatment and Follow-up Probe Results for AC*

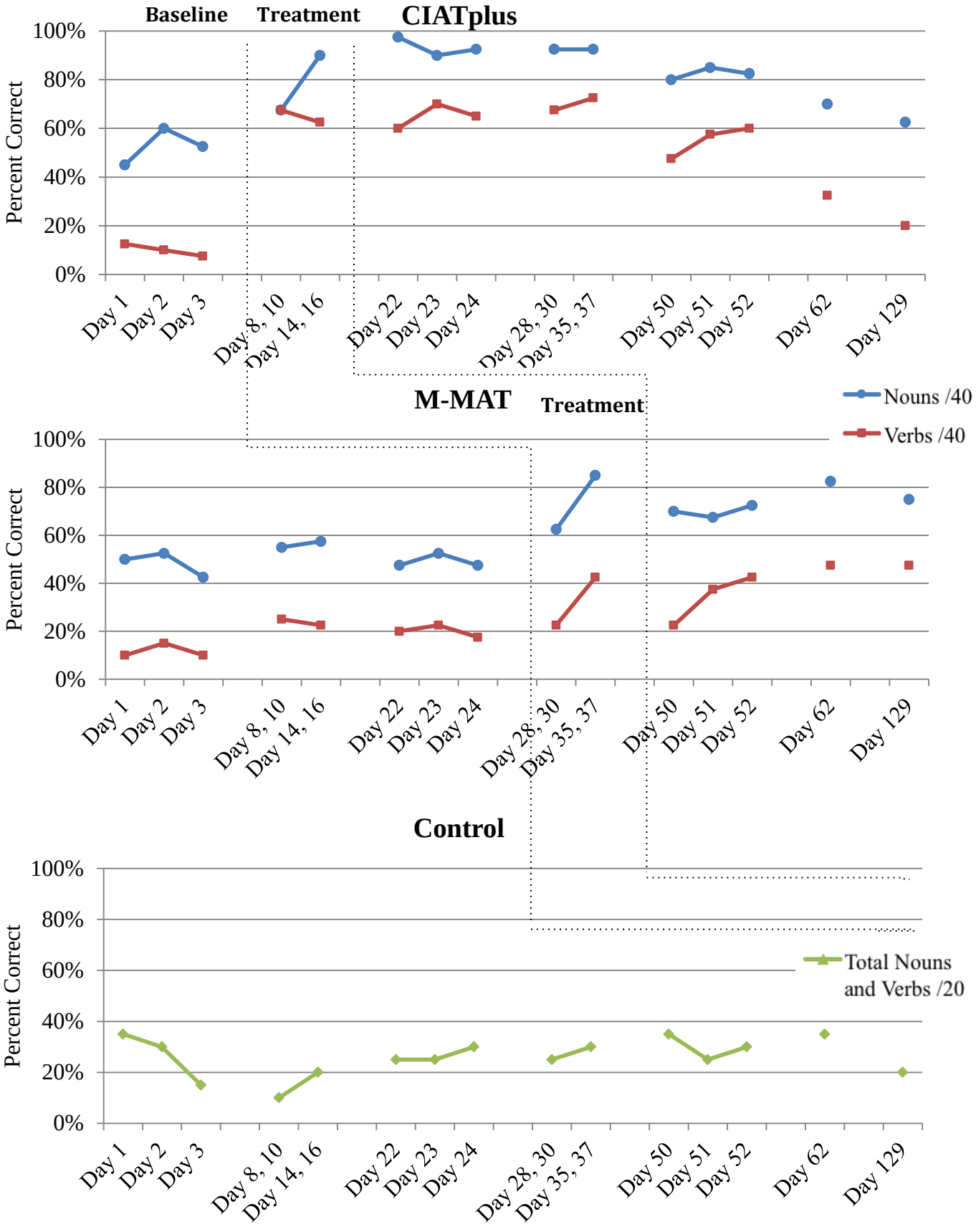

Figure 7. *Comparative Baseline, Treatment and Follow-up Probe Results for LM*

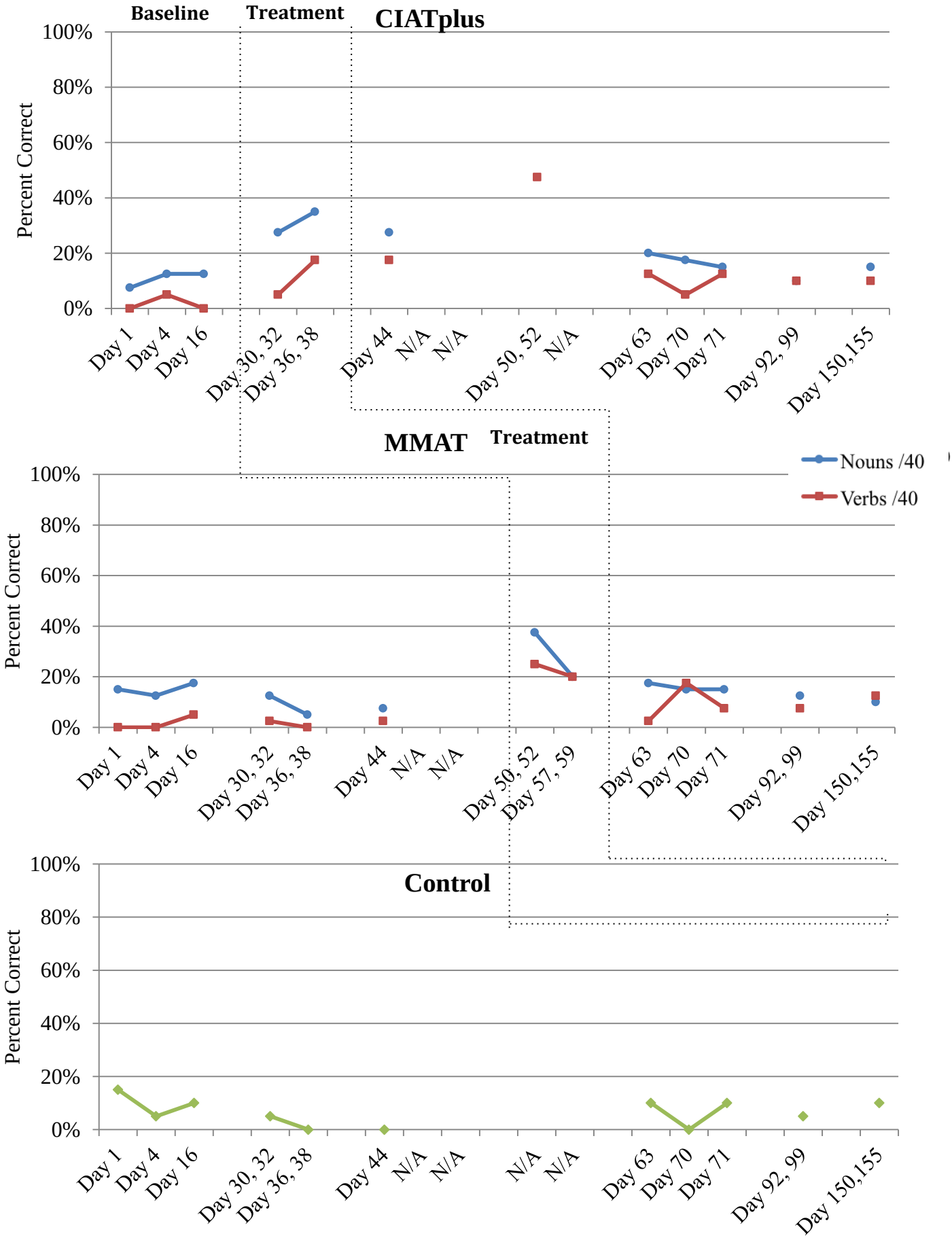

Figure 8. *Comparative Baseline, Treatment and Follow-up Probe Results for PD*

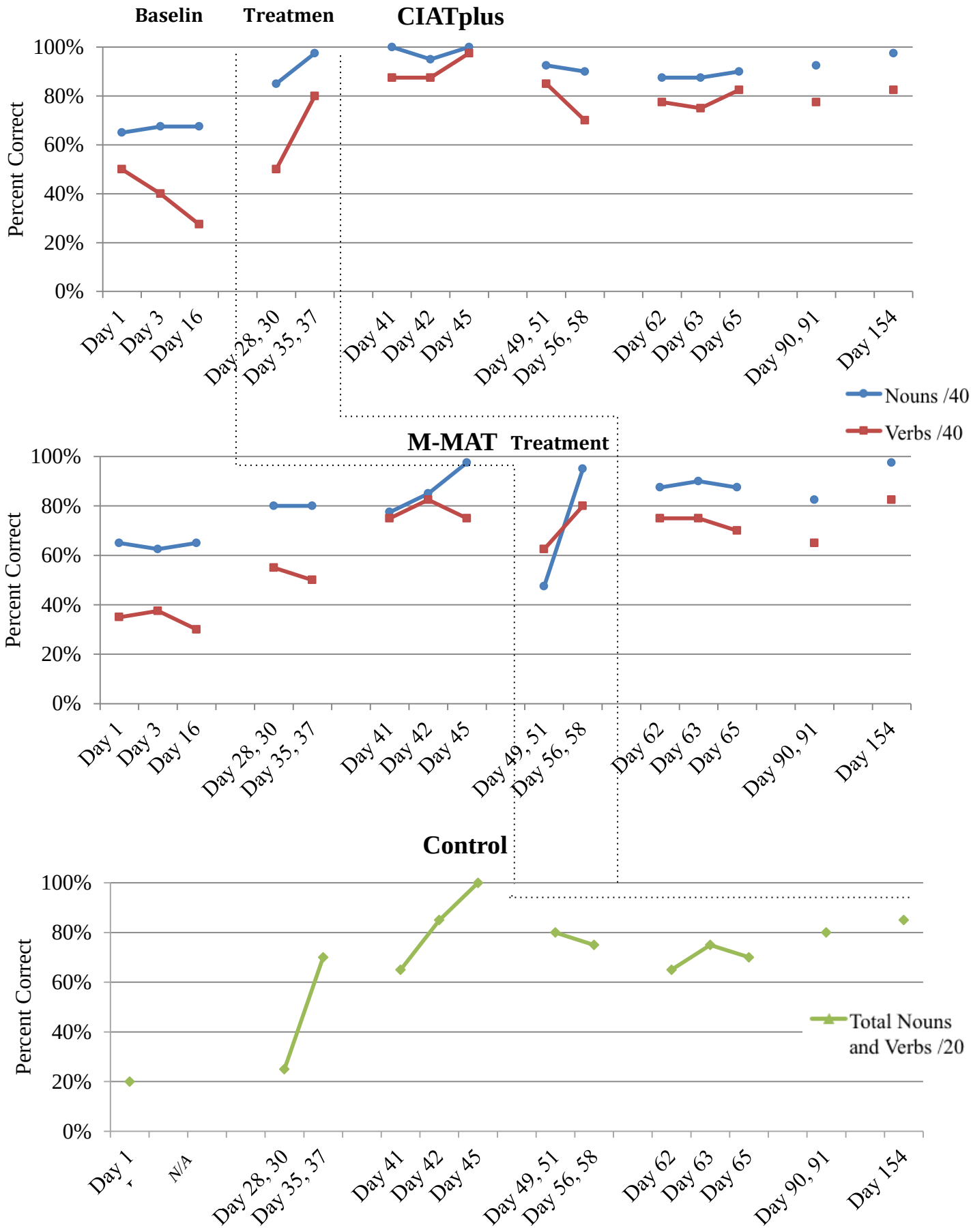

Figure 9. *Comparative Baseline, Treatment and Follow-up Probe Results for ST*

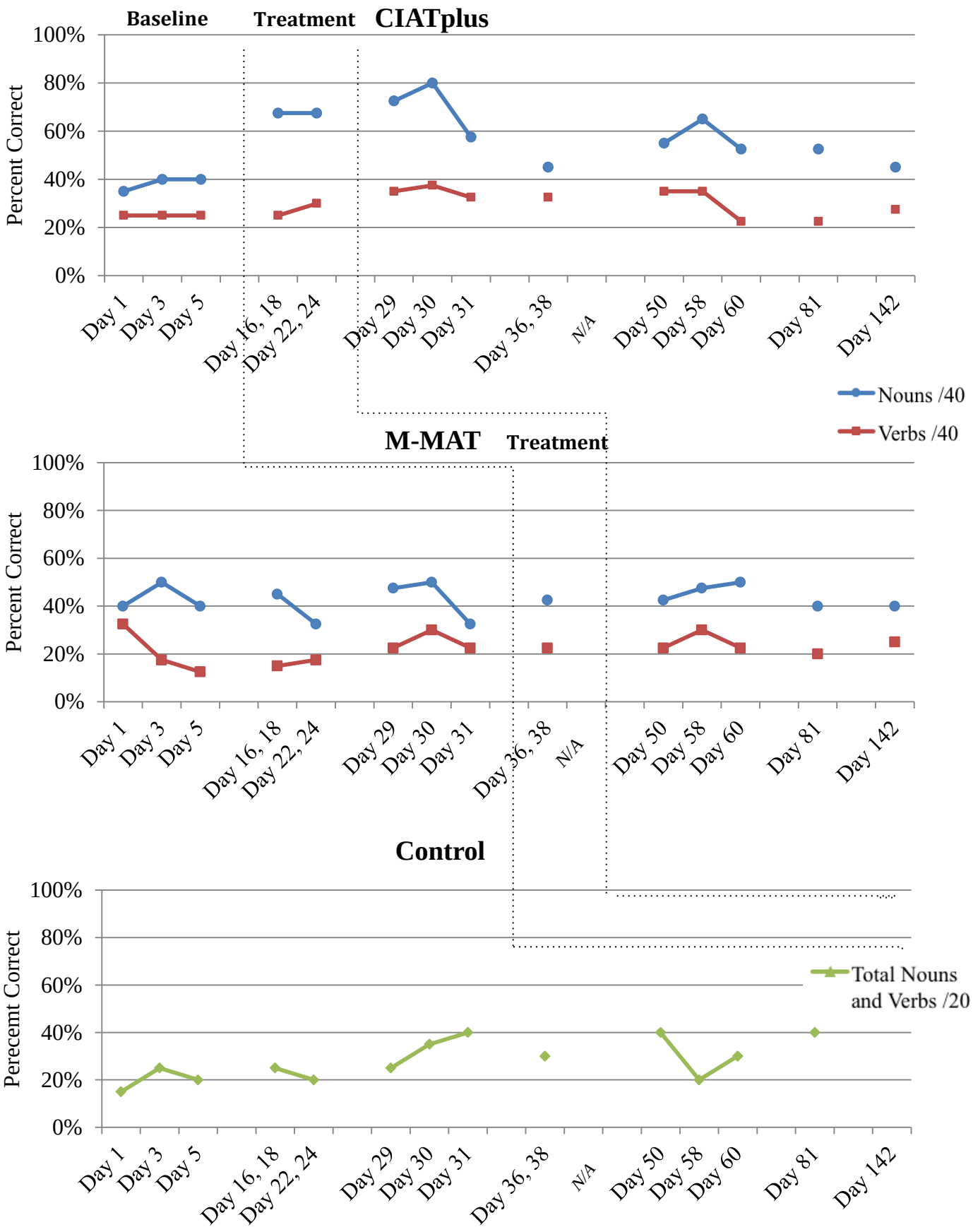

Figure 10. *Comparative Baseline, Treatment and Follow-up Probe Results for JB*

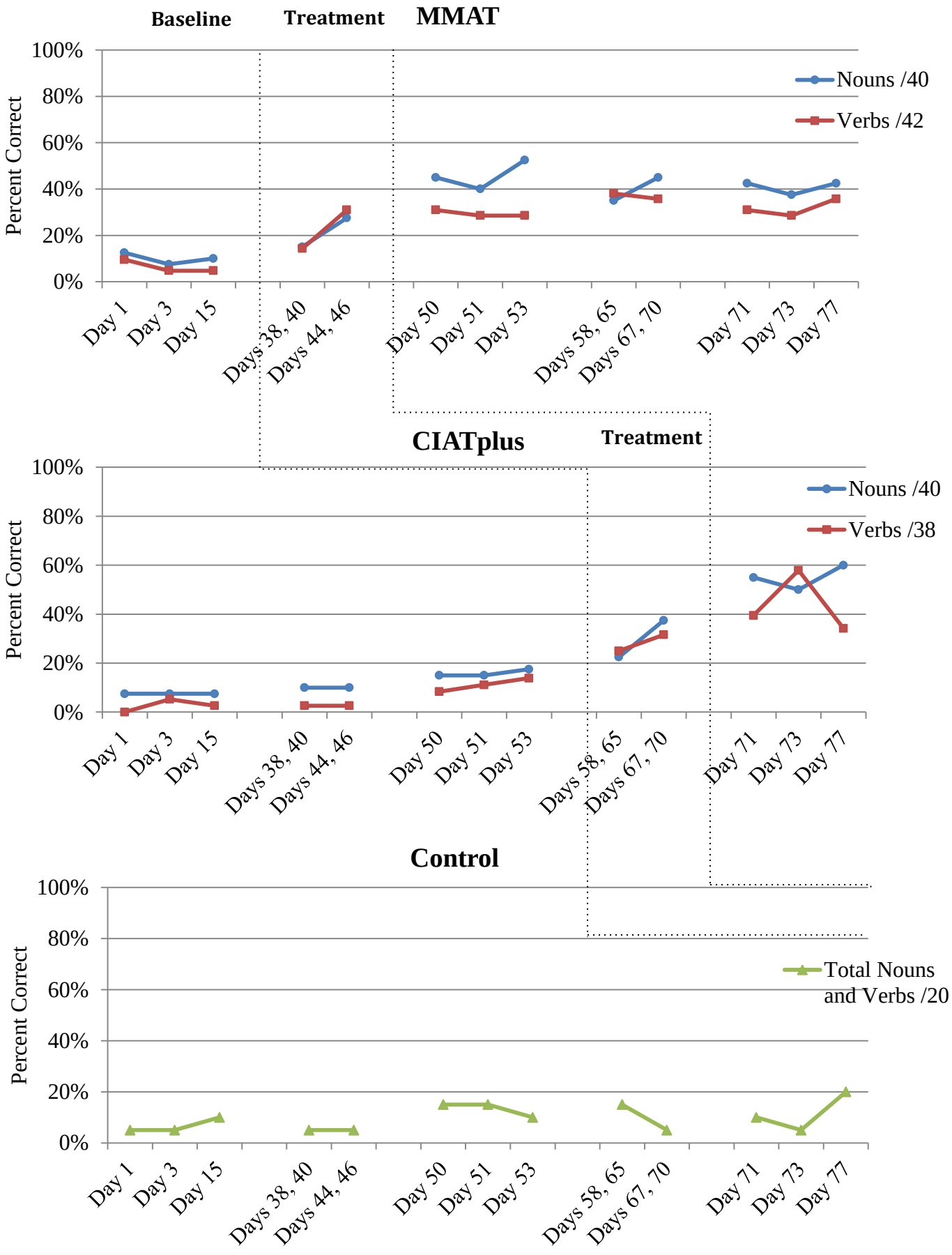

Figure 11. *Comparative Baseline, Treatment and Follow-up Probe Results for PK*