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The Comparative Effects of Multi-modality and Constraint-induced Aphasia Therapy-Plus Treatments for Severe Chronic Aphasia

Summary

Background

Anomia is a characteristic symptom of aphasia. Impairments in functional communication associated with aphasia have been found to negatively impact upon an individual's quality of life (QoL) in a number of areas, including independence and the ability to participate in social and leisure activities (Cruice, Worrall, & Hickson, 2006).

Our review of the literature suggests that measurement of treatment effects has been influenced by treatment type and intensity, the measurement phases applied, the outcome measures used, aphasia severity and type, and the presence of concomitant impairments. It is clear that both constraint-induced and alternative/multi-modality treatments can be effective for reducing anomia. However, the question of which treatments, particularly constraint-induced and alternative/multi-modality treatments, are most efficacious for certain types, severities, and chronicities of aphasia remains unanswered. Only three known studies (Barthel, Meinzer, Djundja, & Rockstroh, 2008; Kurland, Baldwin, & Tauer, 2010; Maher et al., 2006) have involved direct comparisons between constraint-induced and multi-modality interventions. This is a particularly interesting comparison, given the great distinction between the two forms of therapy, and the interpretation that the research underpinning the principle of constraint in aphasia rehabilitation is inconclusive. Further, a number of methodological flaws in the reviewed studies weaken the research findings. Thus, we identified a need for continued study in this area.

Aims and Hypotheses

We conducted a pilot study with the aim to investigate the effectiveness of Constraint-Induced Aphasia Therapy-Plus (CIATplus; Meinzer, Djundja, Barthel, Elbert, & Rochstroh, 2005) (see Table 1 for summary) as compared with Multi-modality Aphasia Therapy (M-MAT; De-identified, in preparation) (see Table 2 for summary) for noun retrieval using picture-naming tasks, in people with severe chronic Broca's aphasia. The secondary aim of the study was to ascertain whether constraining communication to the spoken modality is a critical aspect of successful noun retrieval treatment.

We hypothesised that both treatments (and not one more so than the other) would lead to significantly improved naming response scores for treated stimuli, as well as scores for standardised measures of language impairment and communicative effectiveness at each assessment point. Our prediction was that M-MAT (and not CIATplus) would lead to generalisation to naming for untrained, semantically related items and to discourse. We anticipated that neither treatment would lead to significantly improved naming response scores for untrained, semantically unrelated items and that there would be no significant difference in reported QoL at the end of treatment. Finally, we hypothesised that the participants would evaluate their experiences of both treatments as positive (M-MAT more so than CIATplus).

Method

Two females aged 55 and 58 years (P1 and P2) participated in the study (see Table 3). The design consisted of two single-subject, alternating treatments with multiple probes, with the participants acting as their own controls. In order to determine the effect of constraint on noun retrieval, intensity was controlled for in both interventions. Both Phases 1 and 2 involved collecting data during 3.25-hour treatment sessions with refreshment intervals at each hour (totalling 45 minutes), four days a week, over 2 weeks. Thus, the participants received a total 32 hours of contact during each phase (26 hours of specified treatment plus 6 hours of social interaction). The treatment phases were separated by a 1-week interval. The treatment stimuli (178 items) were generated using pictures from the International Picture-

Naming Project (Szekely, Jacobsen, D'Amico, Devescovi, & Andonova, 2004), Object and Action Naming Battery (Druks & Masterson, 2000), and Snodgrass and Vanderwart Pictures (Snodgrass & Vanderwart, 1980). During treatment, participants named items in the context of the activities including 'Go Fish', 'Bingo', and 'Memory'. They took turns to make and respond to, where applicable, verbal productions of the pictured items. In addition, structured interactions took place, and a home practice component involved transfer request tasks. Naming probes and assessments were conducted at baseline, during and following each treatment, as well as 6 weeks and 3 months post treatment.

Results

A comparison of pre-treatment, post-CIATplus, and post-M-MAT formal assessment results for P1 and P2 are summarised in Table 4. McNemar's test scores and effect sizes for CIATplus and M-MAT are shown in Tables 5-9. Inter-rater reliability was calculated to be 99.44%, and intra-rater reliability was 99.72%. Standard case charts showing the results of naming scores from the naming probe assessments during the various phases of the study are presented in Figures 1 and 2. The treatment effects of CIATplus and M-MAT for naming responses were found to be comparable for P1 in relation to immediate gains. M-MAT proved superior to CIATplus for P2 in generating immediate positive change, as well as for P1 for maintained naming skills up to 3 months post treatment. P2 showed no maintenance of gains as a result of either CIATplus or M-MAT. Overall, generalisation of naming skills beyond treated items to untreated items and other measures of outcome did not occur immediately following either treatment. Participant response to therapy revealed that M-MAT was found to be equally or more enjoyable than CIATplus.

Discussion

The primary aim of this pilot study was met in that the efficacy of two treatments for improving noun retrieval in two participants with severe chronic Broca's aphasia was investigated. The role of verbal constraint was also investigated. CIATplus led to varying degrees of immediate acquisition and maintenance between P1 and P2. While M-MAT was consistent for immediate acquisition, it too resulted in different maintenance results for each participant. Overall, M-MAT proved either comparable or superior to CIATplus. A plausible hypothesis to explain this finding is that there are different cognitive processes inherent in the two treatments which impacts on neuroplasticity and learning. M-MAT is a highly enriched learning paradigm, involving multiple associations: phonologic (speech), orthographic (written), motor and visuo-spatial (drawing and gesture). The theory of interconnectedness between numerous subsystems in the brain (that is, their propensity to set off activity in each another) has been explored in the literature (e.g., Miller, 2006; Paivio, 1986). CIATplus may lack the enrichment process inherent in the numerous neural networks activated through M-MAT. It is speculated that along with treatment type, an interaction between participant characteristics and the degree of intensive treatment may exist, and warrants further investigation.

Overall, generalization to untrained (related and unrelated) stimulus items, discourse, and standardized impairment measures did not occur to a great deal for either participant following either treatment. Communicative effectiveness and QoL scores remained statistically similar to pre-treatment levels. Participant evaluation of the interventions reflected positive feedback (more so for M-MAT than CIATplus for P2) and satisfaction with individual gains.

In relation to clinical implications, it would seem that change can occur (albeit potentially temporary) with participants presenting with severe chronic Broca's aphasia and concomitant cognitive deficits. Beyond this presentation, the findings are difficult to generalise. It is possible that more treatment may be required for larger and more long-lasting results. Alternatively, expectations for improvement may need to be lowered for aphasia of this nature. As constraint does not seem crucial with intensity controlled, applying multi-

modal treatment such as M-MAT in the clinic may be optimal. Finally, in contrast to constraint-induced treatment, M-MAT takes a potent, dynamic approach that can be more enjoyable both to undertake and to conduct. With methodologically stronger replication, further knowledge will contribute to the more effective application of client-tailored treatment practices.

Table 1

CIATplus Cueing Hierarchy—Example for Syntactic Complexity Level 1

Step	Description
1	Participant verbally announces card (e.g., "Couch"). If correct, move on to next card (starting at Level 1, Step 1 again) following partner's turn to announce card. If incorrect, go to Step 2
2	Clinician provides a phonemic cue (e.g., "It starts with /k/"). If correct, move on to next card. If incorrect, go to Step 3
3	Clinician provides a written cue (e.g., '*couch*'") in conjunction with a verbal cue (e.g., 'It's a couch…say 'couch'"). The participant verbally repeats the name three times with the pictured item and written cue in view.

Table 2

M-MAT Cueing Hierarchy—Example for Syntactic Complexity Level 1

Step	Description
1	Participant verbally announces card (noun; e.g., "Couch"). If correct, move on to next card (starting at Level 1, Step 1 again) following partner's turn to announce card. If incorrect, go to Step 2
2 [a]	Ask participant to make an iconic gesture and say the word to announce the pictured item. If item named, move on to next card following partner's turn. If incorrect, go to Step 3
3 [b]	Clinician provides an iconic gesture model. If item named, move on to next card following partner's turn. If participant unable to name item, clinician provides item name [c] and asks participant to repeat with gesture.
4	Ask participant to make a drawing [d] and say the word to announce the pictured item. Clinician provides refinement cues as necessary. Then go to Step 5
5	Clinician provides a written model (word; e.g., *couch*) + verbal model for the participant to copy. Then go to Step 6
6	The participant verbally repeats the name three times with the pictured item and written cue in view.

[a] Any approximation of the gesture was positively reinforced by the clinicians [b] Models were provided either to reinforce the gesture produced, or to indicate that the participant could more closely approximate the desired gesture in instances of incomplete or unrelated productions, or no production [c] This occurred from Day 3 onwards [d] Any drawing which highlighted the characteristic features of the item was positively reinforced.

Table 3

Participant Selection (Pre-treatment) Assessment Results

Assessment	Participant 1	Participant 2
Aphasic Depression Rating Scale (ADRS; Benaim, Cailly, Perennou, & Pelissier, 2004)	1/32	1/32
Apraxia Battery for Adults (ABA; Dabul, 2000)		
Apraxia of Speech	Mild-Moderate	Moderate
Limb Apraxia	Mild	Moderate
Test of Oral and Limb Apraxia (TOLA; Helm-Estabrooks, 1992): Gestured Pictures[a]		
Proximal Limb /15	10	6
Distal Limb /15	7	4
Oral /15	8	5
A Simplified Hand Preference Questionnaire (Bryden, 1982)	0.7 (Right-handed)	+1 (Extreme right-handed)
Coloured Progressive Matrices (Raven, Court, & Raven, 1995)	24/37	21/37
Rey-Osterrieth Complex Figure Test (Rey, 1941; Osterrieth, 1944; as cited in Fastenau, Denburg, & Hufford, 1999)		
Copy	17.5	9
Recall	4.5	1
Pyramids and Palm Trees Test (Howard & Patterson, 1992): 3 Pictures	45/52	35/52
Psycholinguistic Assessments of Language Processing in Aphasia 53 (PALPA 53; Kay, Lesser, & Coltheart, 1992).		
Spoken Picture Naming	N/A	9/40
Written Picture Naming	N/A	4/40
Repetition	N/A	39/40
Reading	N/A	14/40
Writing to Dictation	N/A	6/40

[a] P2's results for this test are likely to be in part confounded by cognitive impairment.

Table 4

Comparison of Pre-Treatment, Post-CIATplus/Inter-phase Interval, and Post-M-MAT Assessment Results: Participants 1 and 2

	Participant 1					Participant 2				
Assessment	Pre tx	Post C+	Post M	6 Wk.	3 Mo.	Pre tx	Post C+	Post M	6 Wk.	3 Mo.
Stroke and Aphasia Quality Of Life Scale (Hilari & Byng, 2001; Hilari, Byng, Lamping, & Smith, 2003):										
Communication Domain /5	3.86		3.86	4.71	4.43	3.14		3.43	3.43	3.86
Psychosocial Domain /5	4.45		4.73	3.55	4.91	4.73		3.91	4.55	4.45
Communicative Effectiveness Index (Lomas et al., 1989) /100	43	46	55	51	53	57	60	68	65	65
Boston Naming Test (Goodglass, Kaplan, & Weintraub, 2001) /60	4	7	11	6	10	2	1	6	8	0
Western Aphasia Battery—Revised (Kertesz, 2007):										
Aphasia Quotient	33.5	34.5	34.9	39.4	39.2	47.3	47.5	52.1	50.5	73.20
Naming and Word Finding Total /10	2.1	3.7	3.9	4.6	4.0	3.3	3.3	3.0	3.3	4.5
Object Naming /60	16	23	25	33	29	24	26	20	20	28
Word Fluency /20	0	6	6	7	7	0	0	0	1	2
Sentence Completion /10	4	5	4	5	5	7	5	8	8	8
Responsive Speech /10	1	4	4	2	2	2	2	2	4	7
Spontaneous Speech—Picture Description:										
Information Content /10	3	2	3	5	3	3	4	6	6	6
Fluency /10	2	2	2	2	2	5	5	5	5	5
On-target, specific nouns	4	5	3	4	11	3	2	2	2	4
Mean on-target, specific nouns per minute (NPM)	-	-	-	-	-	1.09	0.86	1.50	0.82	2.23

Table 4 continued

Comparison of Pre-Treatment, Post-CIATplus/Inter-phase Interval, and Post-M-MAT Assessment Results: Participants 1 and 2

	Participant 1					Participant 2				
Assessment	Pre tx	Post C+	Post M	6 Wk.	3 Mo.	Pre tx	Post C+	Post M	6 Wk.	3 Mo.
Scenario Test (van der Meulen, van de Sandt-Koenderman, Duivenvoorden, & Ribbers, 2010) /54	33	36	37	45	42	31	39	36	38	39
Cinderella Narrative Retell										
Mean words/minute (WPM)						88	106	126	126	128
% Correct Information Units [a] (CIUs; Nicholas & Brookshire, 1993)						44%	45%	51%	31%	46%
Mean CIUs/minute	Not applicable					39	48	64	38	59
On-target nouns (including non-specific [b])						0	4	4	2	3
Mean on-target (including non-specific) nouns/minute						N/A	2.53	1.6	0.76	1.88
On-target, specific verbs						1	1	5	4	3
Semi-Structured Conversation [c]										
On-target, specific nouns	8	5 [d]	13 [e]	8	4	23	27	22	25	22
Mean on-target, specific nouns/minute	-	-	-	-	-	1.81	1.93	2.0	1.86	1.52
On-target, specific verbs	2	0	1 [f]	0	0	15	12	10	13	13

Note: Pre-Tx = Pre-Treatment; Post-C+= Post-CIATplus. I.I = Inter-phase Interval. Post-M= Post-M-MAT. See further below regarding P1's Cinderella Retell responses. P1's mean number of nouns per minute for the Semi-Structured Conversations has not been calculated due to her limited verbal output.

[a] Correct Information Unit analysis allows measurement of the informativeness and efficiency of utterances [b] Non-specific' in this instance refers to nouns such as 'woman' for 'fairy godmother', as opposed to ambiguous nouns such as 'thing' for 'slipper/shoe' [c] Length of conversations: Participant 1—5.5 minutes; Participant 2—20 minutes [d] Includes a noun (porridge) cued with the first syllable by the conversation partner [e] Includes three nouns (proper names) cued with the first sound by the conversation partner [f] Verb (reading) cued with the first sound by the conversation partner

Table 5

McNemar's Test Scores for BNT and WAB—Object Naming—Participants 1 and 2

Assessment	Pre tx vs. Post CIAT+				Post CIAT+ vs. Post-M-MAT				Pre tx vs. Post M-MAT			
	P 1		P2		P 1		P2		P 1		P2	
	McN.	*p*	*McN.*	*p*	*McN.*	*p*	*McN.*	*p*	*McN.*	*p*	*McN.*	*p*
BNT	1.5	.344	0	N/A	4.17	.109	6.25	.062	4.9	.05**	3.2	.188
WAB—Object Naming	0.9	.50	3.2	0.188	0.125	.637	4.17	.016*	0.8	.812	0	N/A

Note: Pre Tx = Pre treatment; CIAT+ = CIATplus; McN. = McNemar's score; Participant 1's values are shaded to facilitate ease of reading

* statistically significant positive change

** statistically significant negative change

Table 6

McNemar's Test Scores and Effect Sizes for CIATplus Probes—Participant 1

Pre tx 1 vs. Post C+ 1		Pre tx 2 vs. Post C+ 2		Pre tx 3 vs. Post C+ 3		Pre tx vs. Post C+	Post C+3^ vs. 6 wks		Post C+ vs. 6 wks	Post C+3^ vs. 3 mo.		Post C+ vs. 3 mo.
McN.	*p*	McN.	*p*	McN.	*p*	*d*	McN.	*p*	*d*	McN.	*p*	*d*
15.75	.001*	14.81	.001*	14.7	.001*	6.33	2.06	.20	-4.62	4	.05**	-5.77

Note: Pre-tx = Pre-treatment; C+ = CIATplus; McN. = McNemar's score; shaded value denotes the immediately post-CIATplus effect size

* statistically significant positive change

** statistically significant negative change

^As there are three data collection points at Post-CIATplus and one data collection point at the 6-week and 3-month follow ups, the researchers applied a conservative measure and selected the value closest to the mean of the three data points at Post-CIATplus to compare with the single values at each follow-up point.

Table 7

McNemar's Test Scores and Effect Sizes for CIATplus Probes—Participant 2

Pre tx 1 vs. Post C+ 1		Pre tx 2 vs. Post C+ 2		Pre tx 3 vs. Post C+ 3		Pre tx vs. Post C+	Post C+3^ vs. 6 wks		Post C+ vs. 6 wks	Post C+3^ vs. 3 mo.		Post C+ vs. 3 mo.
McN.	*p*	McN.	*p*	McN.	*p*	*d*	McN.	*p*	*d*	McN.	*p*	*d*
0.0625	.90	2.4	.70	2.04	.20	1.04	0.9	.50	0.46	0.5625	.5	0.00

Note: Pre-Tx = Pre-Treatment; Post-C+ = Post-CIATplus; McN. = McNemar's score; shaded value denotes the immediately post-CIATplus effect size

^As there are three data collection points at Post-CIATplus and one data collection point at the 6-week and 3-month follow ups, the researchers applied a conservative measure and selected the value closest to the mean of the three data points at Post-CIATplus to compare with the single values at each follow-up point.

Table 8

McNemar's Test Scores and Effect Sizes for M-MAT Probes—Participant 1

Post CIAT+ 1 vs. Post M 1		Post CIAT+ 2 vs. Post M 2		Post CIAT+ 3 vs. Post M 3		Baseline† vs. Post M	Post M 3^ vs. 6 wks		Baseline† vs. 6 wks	Post M 3^ vs. 3mo.		Baseline† vs. 3 mo.
McN.	*p*	McN.	*p*	McN.	*p*	*D*	McN.	*p*	*d*	McN.	*p*	*d*
23.31	.001*	6.04	.02*	5.94	.02*	4.27	1.14	.30	2.18	3.38	.10	1.92

Note: CIAT+ = CIATplus; Post M = Pos M-MAT; McN. = McNemar's score; shaded value denotes the immediately post-M-MAT effect size

* statistically significant positive change

† 'Baseline' in this case involves the pooled standard deviation of the eight data points prior to M-MAT (Pre-Treatment 1-3, T1 [2,4], T1 [6,8], Post-CIATplus 1-3)

^As there are three data collection points at Post-M-MAT and one data collection point at the 6-week and 3-month follow ups, the researchers applied a conservative measure and selected the value closest to the mean of the three data points at Post-M-MAT to compare with the single values at each follow-up point.

Table 9

McNemar's Test Scores and Effect Sizes for M-MAT Probes—Participant 2

Post CIAT+ 1 vs. Post M 1		Post CIAT+ 2 vs. Post M 2		Post CIAT+ 3 vs. Post M 3		Baseline† vs. Post M	Post M 3^ vs. 6 wks		Baseline† vs. 6 wks	Post M 3^ vs. 3mo.		Baseline† vs. 3 mo.
McN.	*p*	McN.	*p*	McN.	*p*	*d*	McN.	*p*	*d*	McN.	*p*	*d*
1.23	.30	20.35	.001*	17.93	.001*	4.53	16.00	.001**	-0.09	9.38	.001**	1.04

Note: CIAT+ = CIATplus; Post-M = Post M-MAT; McN. = McNemar's score; Bold type font denotes statistically significant positive change; Italic type font denotes effect size comparison points; The shaded value denotes the immediately post M-MAT effect size

* statistically significant positive change

** statistically significant negative change

† 'Baseline' in this case involves the pooled standard deviation of the eight data points prior to M-MAT (Pre-Treatment 1-3, T1 [2,4], T1 [6,8], Post-CIATplus 1-3)

^As there are three data collection points at Post-M-MAT and one data collection point at the 6-week and 3-month follow ups, the researchers applied a conservative measure and selected the value closest to the mean of the three data points at Post-M-MAT to compare with the single values at each follow-up point.

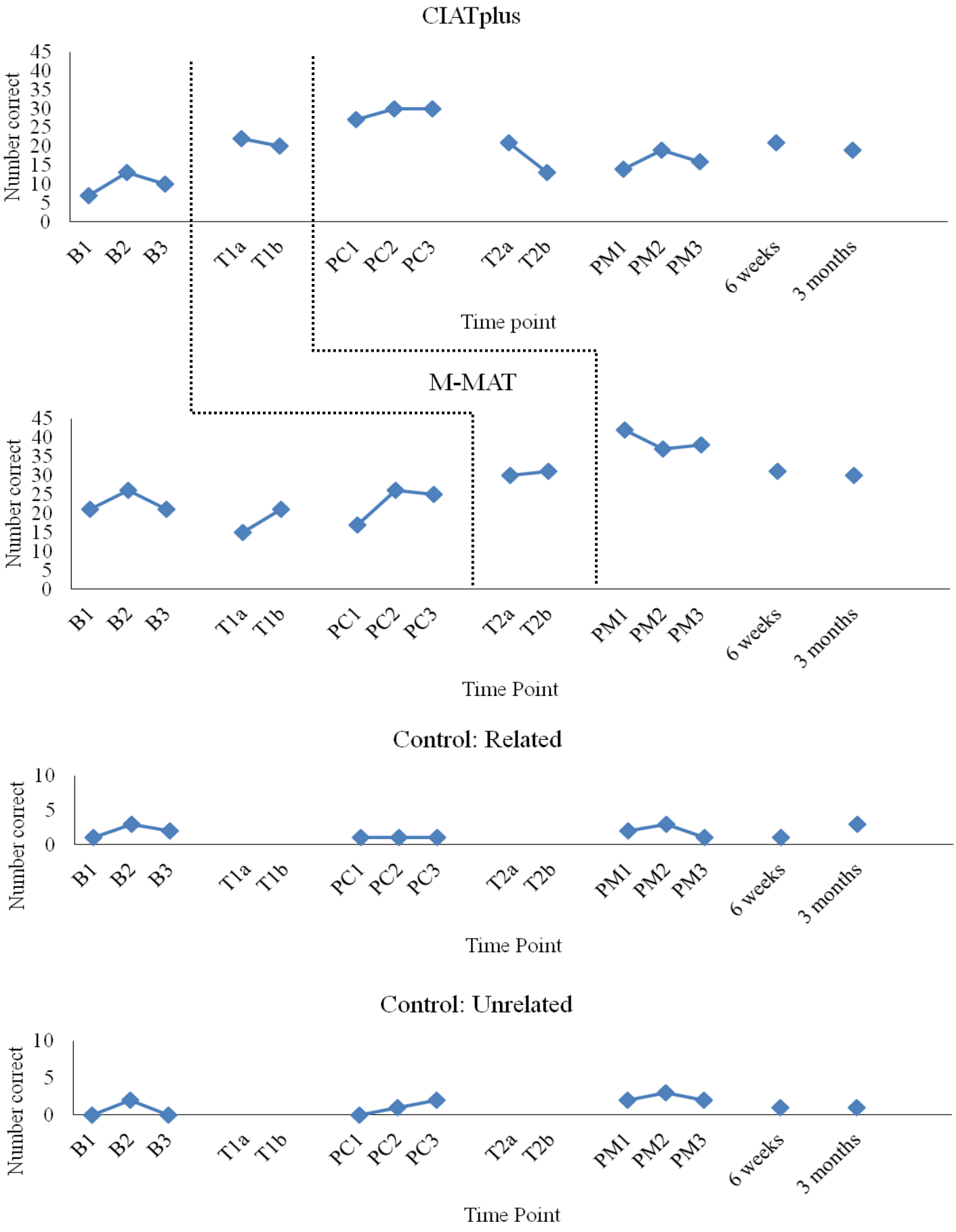

Figure 1. Comparative Baseline, Treatment and Follow up Probe Results for Participant 1

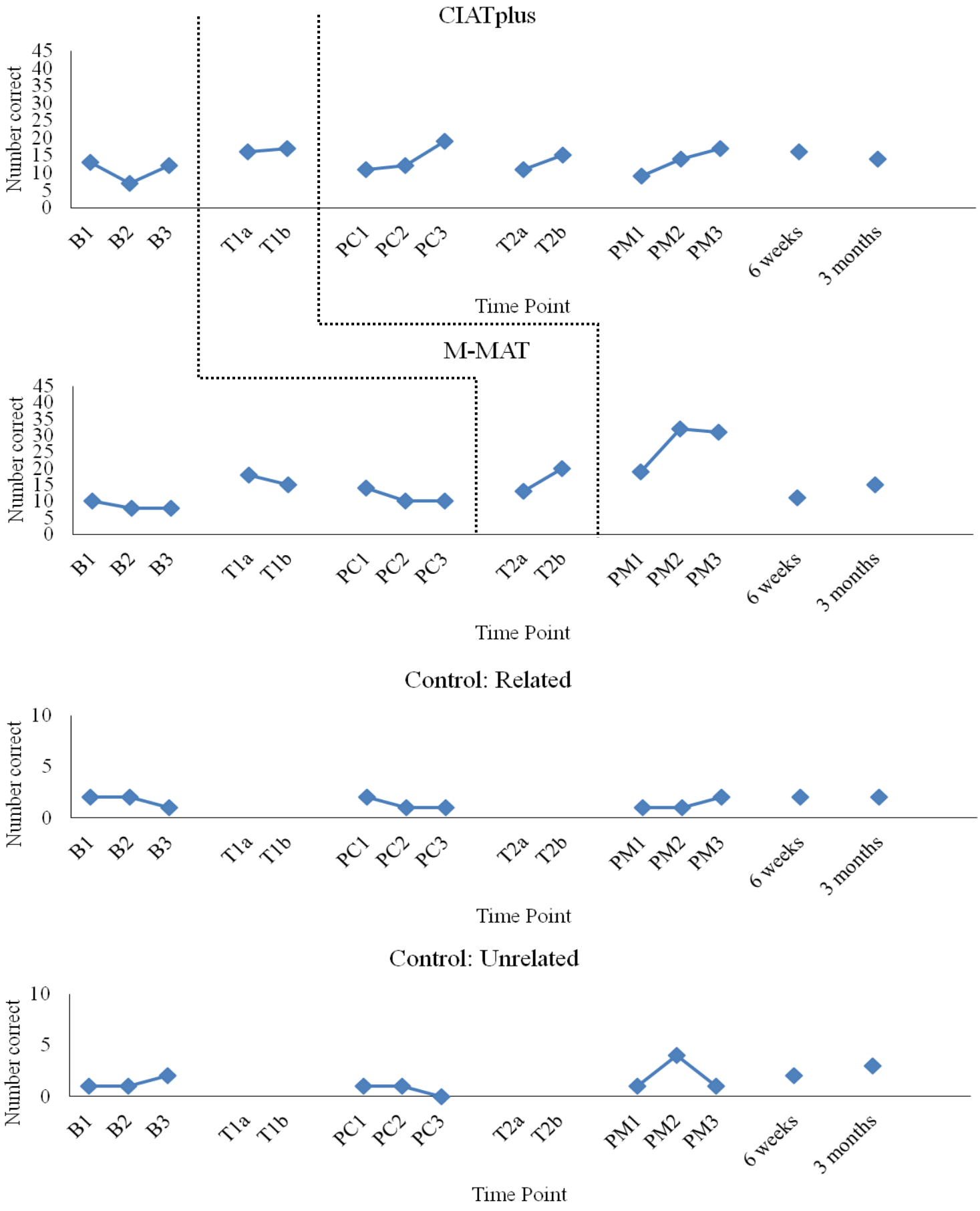

Figure 2. Comparative Baseline, Treatment and Follow up Probe Results for Participant 2

References

Barthel, G., Meinzer, M., Djundja, D., & Rockstroh, B. (2008). Intensive language therapy in chronic aphasia: Which aspects contribute most? *Aphasiology, 22*(4), 408-421.

Benaim, C., Cailly, B., Perennou, D., & Pelissier, J. (2004). Validation of the Aphasic Depression Rating Scale. *Stroke, 35*(7), 1692-1696.

Bryden, M. (1982). Handedness and its relation to cerebral function. In M. Bryden (Ed.), *Laterality: Functional asymmetry in the intact brain* (pp. 157-179). New York: Academic Press.

Cruice, M., Worrall, L., & Hickson, L. (2006). Perspectives of quality of life by people with aphasia and their family: Suggestions for successful living. *Topics in Stroke Rehabilitation, 13*(1), 14-24.

Dabul, B. (2000). *Apraxia Battery for Adults* (2nd ed.). Austin: Pro-Ed.

De-identified. (in preparation). The effects of Multi-modality Aphasia Treatment (M-MAT) for anomia.

Druks, J., & Masterson, J. (2000). An Object and Action Naming Battery. Philadelphia: Psychology Press.

Fastenau, P. S., Denburg, N. L., & Hufford, B. J. (1999). Adult norms for the Rey-Osterrieth Complex Figure Test and for supplemental recognition and matching trials from the extended Complex Figure Test. *Clinical Neuropsychologist, 13*(1), 30-47.

Goodglass, H., Kaplan, E., & Weintraub, S. (2001). Boston Naming Test. Philadelphia: Lippincott Williams & Wilkins.

Helm-Estabrooks, N. (1992). *Test of oral and limb apraxia*. Chicago: The Riverside Publishing Company.

Hilari, K., & Byng, S. (2001). Measuring quality of life in people with aphasia: The Stroke Specific Quality of Life Scale. *International Journal of Language and Communication Disorders, 36*(SUPPL.), 86-91.

Hilari, K., Byng, S., Lamping, D. L., & Smith, S. C. (2003). Stroke and Aphasia Quality of Life Scale-39 (SAQOL-39): Evaluation of acceptability, reliability, and validity. *Stroke, 34*(8), 1944-1950.

Howard, D., & Patterson, K. (1992). The Pyramids and Palm Trees Test. Suffolk: Thames Valley Test Company.

Kay, J., Lesser, R., & Coltheart, M. (1992). Psycholinguistic Assessments of Language Processing in Aphasia. Hove: Lawrence Erlbaum Associates Ltd.

Kertesz, A. (2007). Western Aphasia Battery-Revised. San Antonio: The Psychological Corporation.

Kurland, J., Baldwin, K., & Tauer, C. (2010). Treatment-induced neuroplasticity following intensive naming therapy in a case of chronic Wernicke's aphasia. *Aphasiology, 24*(6-8), 737-751.

Lomas, J., Pickard, L., Bester, S., Elbard, H., Finlayson, A., & Zoghaib, C. (1989). The Communicative Effectiveness Index: Developmental and psychometric evaluation of a functional communication measure for adult aphasia. *Journal of Speech and Hearing Disorders, 54*(1), 113-124.

Maher, L. M., Kendall, D., Swearengin, J. A., Rodriguez, A., Leon, S. A., Pingel, K., et al. (2006). A pilot study of use-dependent learning in the context of Constraint Induced Language Therapy. *Journal of the International Neuropsychological Society, 12*(6), 843-852.

Meinzer, M., Djundja, D., Barthel, G., Elbert, T., & Rochstroh, B. (2005). Long-term stability of improved language functions in chronic aphasia after constraint-induced aphasia therapy. *Stroke, 36*, 1462-1466.

Miller, N. (2006). Utility of arm and hand gestures in the treatment of aphasia: Some comments and expansions. *Advances in Speech-Language Pathology, 8*(2), 143-148.

Nicholas, L. E., & Brookshire, R. H. (1993). A system for quantifying the informativeness and efficiency of the connected speech of adults with aphasia. *Journal of Speech, Language, and Hearing Research, 36*(4), 338-350.

Paivio, A. (1986). *Mental representations: A dual coding approach*. New York: Oxford University Press.

Raven, J. C., Court, J., & Raven, J. (1995). Coloured Progressive Matrices. Oxford: Oxford Psychologists Press.

Snodgrass, J. G., & Vanderwart, M. (1980). A standardized set of 260 pictures: Norms for name agreement, image agreement, familiarity, and visual complexity. *Journal of Experimental Psychology: Human Learning and Memory, 6*(2), 174-215.

Szekely, A., Jacobsen, T., D'Amico, S., Devescovi, A., & Andonova, E., et al. (2004). A new on-line resource for psycholinguistic studies. *Journal of Memory and Language, 51*, 247-250.

van der Meulen, I., van de Sandt-Koenderman, W. M. E., Duivenvoorden, H. J., & Ribbers, G. M. (2010). Measuring verbal and non-verbal communication in aphasia: Reliability, validity, and sensitivity to change of the scenario test. *International Journal of Language and Communication Disorders, 45*(4), 424-435.