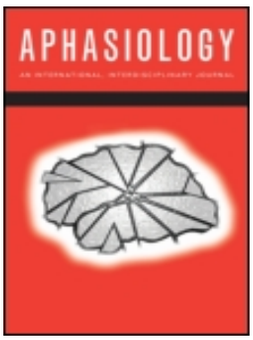

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The comparative effects of Multi-Modality Aphasia Therapy and Constraint-Induced Aphasia Therapy-Plus for severe chronic Broca's aphasia: An in-depth pilot study

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Background: Anomia is a debilitating symptom of aphasia, which impacts significantly on patient quality of life. There is strong evidence in the literature to indicate that treatments for anomia are successful for individuals with aphasia, including those in the chronic stage. However, numerous limitations exist within the methodologies of relevant studies. It remains unclear which treatments provide optimal benefits for varying types and severities of aphasia.
Aims: The primary aim of this study was to compare the effectiveness of two treatments, Constraint-Induced Aphasia Therapy-Plus (CIATplus) and Multi-modality Aphasia Therapy (M-MAT) for noun retrieval in individuals with severe chronic Broca's aphasia. The secondary aim was to investigate whether the use of verbal constraint is an essential element of therapy. We hypothesised that M-MAT and CIATplus would lead to equally improved naming scores for treated stimuli.
Methods & Procedures: Two females with chronic Broca's aphasia (CH and MT) participated in the study. We utilised two single-participant, alternating treatment designs with multiple probes. For each treatment participants received 3.25-hour treatment sessions along with 45 minutes social interaction 4 days a week, for 2 weeks (32 hours total). Treatment involved naming items in the context of turn-taking card games and home transfer request tasks. Naming probes and assessments were conducted at baseline, following each treatment, and at 6 weeks and 3 months post treatment.
Outcomes & Results: Both participants differed in their responses to the treatments. However, M-MAT proved equally efficacious as CIATplus for naming of treated items. Overall, generalisation was not observed for any of the measures. CH reported enjoying both treatments, while MT preferred M-MAT.
Conclusions: As expected, a number of variables are likely to have contributed to differences in participant responses to treatment. Replication with larger, well-stratified

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samples is required to better ascertain the effects of CIATplus and M-MAT on anomia in different types and severities of aphasia. This information would contribute to the more effective application of client-tailored treatment practices.

Keywords: Anomia; Broca's aphasia; Constraint-Induced Aphasia Therapy-Plus; CIATplus; Multi-modality Aphasia Therapy; M-MAT; Nouns; Naming.

Anomia is one of the major, chronic communication difficulties that individuals with aphasia experience. Quality of life (QoL) is significantly impacted (Ross & Wertz, 2000; Worrall & Holland, 2003), with many individuals presenting with co-occuring depression (Bays, 2001) and occupational problems (Dalemans, De Witte, Wade, & Van den Heuvel, 2008; Herrmann & Wallesch, 1989; Le Dorze & Brassard, 1995). Therefore finding effective treatments for aphasia is vital. Severe aphasia is found to more negatively affect psychosocial wellbeing (Hilari, Wiggins, Roy, Byng, & Smith, 2003) and social health (Code, 2003; Hilari, Wiggins, et al., 2003). Of the nonfluent aphasias, Broca's aphasia is the most typical form (Hallowell & Chapey, 2008), and has been well researched (e.g., Rose & Douglas, 2001; Pulvermüller et al., 2001). There is much support in the literature for the continued rehabilitation of patients in the chronic stage of aphasia (e.g., Meinzer, Elbert, Wienbruch, Djundja, & Rockstroh, 2004) when the effects of spontaneous recovery have ceased (Pulvermüller & Berthier, 2008; Robey, 1998). Although treatments for anomia are known to be largely effective, tailoring treatments to match patient characteristics is difficult due to the absence of research accounting for crucial treatment and patient variables that may influence outcomes.

Constraint-Induced Aphasia (Language) Therapy (CIAT/CILT; Pulvermüller et al., 2001) is an intensive aphasia therapy whereby communication is *constrained* to the spoken modality. CIATplus (Meinzer, Djundja, Barthel, Elbert, & Rochstroh, 2005), an extension of CIAT which includes written word stimuli and a home practice programme, has been found to be more effective than its precursor (Meinzer et al., 2005). Participant frustration at having their communication constrained to speaking has been reported (Maher et al., 2006). We argue that along with changes in impairment and functioning, the patient experience of treatment is relevant to the evaluation of treatment effectiveness. Thus investigation regarding the value of the various constraints (spoken responses only, socially motivated communication tasks) included in CIAT seems warranted.

Positive outcomes are evidenced when treating spoken communication through the use of writing (DeDe, Parris, & Waters, 2003; Wright, Marshall, Wilson, & Page, 2008), gesture (Rose, 2006), and drawing (Farias, Davis, & Harrington, 2006). We propose that combining each of these non-verbal cues within a structured multi-modality treatment programme would form a potent, holistic therapy that not only achieves improved word retrieval but also provides *functional* communication tools should word retrieval fail. The investigation of novel multi-modality treatments compared with CIAT/CIATplus is required to better inform treatment practices for anomia, particularly in relation to the topic of constraining therapy practices to the spoken modality.

In her review of anomia rehabilitation Nickels (2002) has established that a number of patient and treatment characteristics, and measurement issues, are important for treatment effectiveness and the determination of this effectiveness. Therefore we suggest that the conclusions of studies are only as valid as the degree of consideration

given to these characteristics and issues. In light of these characteristics a critique of studies reviewed for the present paper now follows.

PATIENT CHARACTERISTICS

As patient characteristics have a major impact on treatment efficacy, their consideration in determining patient candidacy for aphasia rehabilitation is essential. For instance, cognitive skills are a predictor of therapy outcome, immediately and in the long-term (Lambon Ralph, Snell, Fillingham, Conroy, & Sage, 2010; van de Sandt-Koenderman et al., 2008). In relation to characteristics including aphasia type and chronicity, and co-morbidities such as apraxia of speech, treatment and comparison groups in anomia research are heterogeneous overall. As well as rendering generalisation more achievable, controlling for such characteristics may improve understanding of the mechanisms underlying successful treatments.

TREATMENT CHARACTERISTICS

Treatment type

A comparison between CIAT and a multi-modality treatment, Promoting Aphasics' Communicative Effectiveness (PACE; Davis & Wilcox, 1985) for naming skills was made with nine participants (moderate aphasia; type not stated; Maher et al., 2006). PACE aims at communication of messages (in this case object names) through any modality. Results indicated that the treatments had comparable positive outcomes on objective measures. However, the study bears a number of limitations. The researchers note that two participants in the PACE group preferred to employ the spoken modality alone (with one refusing to use any other modality). It is thus unlikely that these participants benefited from the *nonverbal* therapeutic devices embedded within PACE. In addition, the researchers state that participants receiving PACE " . . . were encouraged to use any and all methods available . . . " (p. 846). However, this claim appears inaccurate, as the report suggests that the spoken modality was *not encouraged* in the PACE treatment. Thus gesture and other modalities may have been a replacement for, rather than an adjunct to speech production, which seems somewhat at odds with speech production rather than communication being the overall goal of the study. We argue that every modality available to participants ought to be equally encouraged within alternative-modality treatments (thus creating a multi-modal treatment) but that the goal should be spoken production wherever possible.

Inclusion of constraint

The use of constraint in aphasia therapy is a topical issue. Contrary to the assertions made by the authors of CIAT (e.g., Pulvermüller et al., 2001), there is evidence in the literature to suggest that with the intensity of treatment controlled across groups, verbally constraining communication is not crucial for successful aphasia rehabilitation. Model-Oriented Aphasia Therapy (MOAT; Barthel, Meinzer, Djunda, & Rockstroh, 2008) is a treatment that differs from CIAT in that it does not involve constraint, it includes reading and writing, and is based on linguistic and strategy approaches, with the additional involvement of relatives for home practice

(Barthel et al., 2008). CIAT/CIATplus and MOAT have been found to yield comparable results when delivered at the same intensity (Barthel et al., 2008). Similar equal effects exist for evaluations of CIAT versus PACE in single subject designs (Kurland, Baldwin, & Tauer, 2010; Maher et al., 2006). The necessity of constraint is further brought into question by research into gesture and lexical access (Rauscher, Krauss, & Chen, 1996) and gesture and spatial memory (Morsella & Krauss, 2004) indicating that constraining gestures negatively impacts on naming in healthy speakers. We suggest that preventing the natural gesture act in a population who experience significant verbal communicative deficit is questionable. Moreover, the potential to cause participants to experience frustration (Maher et al., 2006) raises concern; such an outcome may outweigh other benefits of the therapy for some individuals.

MEASUREMENT ISSUES

Outcome measurement

The specific primary outcome measure of pre-post naming scores for *target stimuli* is not often included in the literature (e.g., Pulvermüller et al., 2001; Szarflarski et al., 2008), although it appears more common for alternative modality treatment studies (e.g., Rose & Douglas, 2001, 2008). Unlike standardised measures, this information forms the best representation of an individuals' learning of the target stimuli during treatment. Further, a periodically administered treatment probe is also frequently lacking (see Barthel et al., 2008; Kirmess & Maher, 2010; Maher et al., 2006). This prevents the observation of treatment effects over time, which is valuable information in the testing of novel treatments.

TREATMENT COMPARISONS IN PATIENTS WITH CHRONIC, SEVERE BROCA'S APHASIA

While evidence suggests that speech pathology treatment for chronic anomia is effective, the question of which particular treatments produce the maximum gains for specific types and severities of aphasic impairment remains unanswered. Broca's aphasia is a common form of severe aphasia that includes significant word-retrieval impairments and has frequently been investigated in previous treatment studies. However, direct comparisons between constraint-induced and multi-modality interventions (e.g., Barthel et al., 2008; Kurland et al., 2010) are less common than other combinations (e.g., Faroqi-Shah & Virion, 2009; Meinzer et al., 2005). From these pilot-level studies it appears that multi-modality methods may be comparable to constraint-induced treatments for improving word retrieval, and perhaps even more potent for maintenance and generalisation (e.g., Rose, Douglas, & Matyas, 2002; Rose & Douglas, 2008). This is a particularly important comparison that requires further attention, given the great distinction between the two forms of therapy and the inconclusive research underpinning constraint in aphasia rehabilitation (Barthel et al., 2008). Therefore a thorough pilot study is necessary to illuminate the key elements of treatment design and response before large-scale, multi-presentation studies are conducted.

AIMS AND HYPOTHESES

The primary aim of this pilot study was to investigate the efficacy of CIATplus as compared with Multi-Modality Aphasia Therapy (M-MAT; Rose & Attard, 2011) for noun retrieval using picture-naming tasks, in people with severe chronic Broca's aphasia. The secondary aim was to ascertain whether constraining communication to the spoken modality is a critical aspect of successful noun retrieval treatment. We predicted that: (1) both CIATplus and M-MAT would lead to significantly improved naming response scores for treated stimuli immediately post treatment and at 6-week and 3-month follow ups; and (2) there would be no significant difference *between* improved naming scores for items trained in CIATplus as compared to M-MAT.

METHOD

Participants

In line with patient characteristics known to impact treatment efficacy reviewed above, two participants (CH and MT) presenting with word retrieval deficits were recruited: CH with word retrieval deficits hypothesised to be primarily at the phonological output level, and MT with a mixed semantic/phonological impairment. The participants met the following inclusion and exclusion criteria: they sustained a single left hemispheric stroke at least 12 months prior to the study; they presented with severe Broca's aphasia (Western Aphasia Battery—Revised (WAB) profile (Kertesz, 2007); paucity of verbs compared to nouns; and agrammatic output in MT). They did not have severe limb apraxia or severe apraxia of speech; there was no other history of neurological, psychological, or uncorrected sensory deficits; no history of substance abuse; they were not formally trained in drawing; they were not currently receiving speech therapy; they were right-handed pre-morbidly; and English was their first and only language. A summary of the demographic results for both participants is provided in Table 1.

Pre-treatment assessment

The type and severity of each participant's aphasia, speech, language, and selected cognitive functions were ascertained by the pattern of test results obtained from a range of standardised assessments (see Table 2). Both participants demonstrated

TABLE 1
Participants' demographic details: CH and MT

	Participant	
Characteristic	*CH*	*MT*
Age at time of study	55	58
Months post onset	82	117
Limb apraxia	Mild	Moderate
Apraxia of speech	Mild-moderate	Moderate
Hemiparesis	Right	Right
Pre-stroke handedness	Right	Right

TABLE 2
Treatment activity descriptions

Activity	*Materials*	*Procedure*	*Carrier Phase at Level 2*
Go Fish	Deck of cards from a particular set for each participant (P)	Start with five cards each Take turns to request cards to make pairs If pair, Ps chooses another card from deck to add to set of 5 If no pair, P "goes fishing" for another card Continue until each item named or activity changed	"I want/need a . . . " " Do you have a . . . "
Bingo	Half a deck of cards from a single set each A4-sized laminated sheet with nine different pictured items on it for each P Counters (e.g., wooden blocks) There were four boards for each set; two "winner" boards and two "runner-up" boards	Ps randomly assigned either a winner or runner-up board Ps place a counter on board if matching item named. P who to fills board first "wins" Half-decks then swapped over and shuffled so Ps able to name the second half of the items in the set (new boards)	"I have a . . . " "Do you have a . . . "
Board Game	Deck of cards from a single set each Laminated coloured board (approximately 35 × 49cm) Counters (e.g., wooden blocks) and a die	Take turns to role die, move counter, and name a picture card. P who reaches end point on board first 'wins'	"I saw/have a . . . "
Memory	Two decks of cards from a single set	Cards placed face-down in a shared space Take turns to pick two cards and name with aim of finding pairs If no pair, place cards face-down for next turn If pair found, remove from game P with most pairs at end of game "wins"	**Initially**: Goal-directed carrier phrases: e.g., for the first card selected the P could say "I want a (first item)" in lieu of finding its pair. If pair not found, P was encouraged to say, "I don't want a (second item)". If pair was found, P could say, "I have a couch" **Eventually**: Carrier phrase reduced to "I have a . . . " for all cards as the above became overly confusing for the Ps

(*Continued*)

TABLE 2
(Continued)

Activity	*Materials*	*Procedure*	*Carrier Phase at Level 2*
Carrier Phrases	Deck of cards each from a single set	Due to the P's aphasia severity, clinician provided an opening scene applicable to each item selected e.g., when item was an animal/item of furniture/item of clothing: "You went to the zoo/IKEA/Myer and . . . "	"I saw/bought a . . . "
Request Role-Plays	Deck of cards each from a single set	Using an opening scene phrase, clinician explains that the P (speaker/customer) is in a certain store, e.g., the greengrocer's	**Speaker/customer**: "Do you have a . . . " "I want/need a . . . " **Listener/salesperson**: "No, sorry", "Yes, over there", etc. Over time, clinicians faded out opening scene. Ps were then encouraged to initiate and conclude role-play with short 'mannerisms' such as "Hello" and "Okay then", "Thank you", or "Bye".

mildly reduced semantic access from pictures, and MT presented with poor visuo-constructive skills and visual memory. Assessment was conducted either by the first author, a final-year student researcher or by the third author, a qualified speech pathologist.

Research design

This pilot study utilised two single-participant experimental designs, with alternating treatments and multiple probes, with the participants acting as their own controls. In order to determine the effect of constraint on noun retrieval, intensity was controlled in both interventions. Assessments were conducted prior to CIATplus, immediately following both CIATplus and M-MAT, and at 6 weeks and 3 months post M-MAT. Both treatment phases involved collecting data during 3.25-hour treatment sessions with refreshment intervals at each hour (totalling 45 minutes), 4 days a week, for 2 weeks: a total of 32 hours of contact during each phase (26 hours of specified treatment plus 6 hours of social interaction per phase). One week separated the CIATplus and M-MAT treatment phases. All sessions were video-recorded.

Treatment stimuli

The treatment stimuli were generated using pictures from a number of semantic categories from the International Picture-Naming Project (Szekely et al., 2004), Object and Action Naming Battery (Druks & Masterson, 2000), and Snodgrass and Vanderwart Pictures (Snodgrass & Vanderwart, 1980). These picture sets were selected as the items all have good name agreement and are able to be matched for psycholinguistic properties known to influence word retrieval (e.g., word frequency, imageability, syllable length and complexity). Of these items, 66 were trained in CIATplus and 67 in M-MAT, with 20 items serving as untreated controls (10 semantically related and 10 semantically unrelated items). Eight different categories of nouns were utilised: four in CIATplus and four in M-MAT.

Probing of the entire stimulus corpus took place at each phase: three probes at pre-treatment, post CIATplus, and post M-MAT; and one probe at each of the 6-week and 3-month follow ups. In addition, probing of the *target* stimuli (133 items) took place at the beginning of every second treatment session (half of the 133 items were probed on each occasion, so that the entire treated set was probed twice across each treatment phase). During probing, the items were presented individually on single-sided, white A4 paper. Scoring criteria are outlined in Appendix A.

The first and third authors conducted the interventions. During treatment participants named items in the context of six activities (see Table 3). They took turns to make and respond to verbal productions of the pictured items.

The stimulus items were presented on single-sided, white laminated cards the size of standard playing cards (approximately 6 cm × 9 cm). There was no significant difference for written word frequency (Kucera-Francis, 1967; as cited in Szekely et al., 2004) between any of the sets (CIATplus/M-MAT: $t = -0.49$, $p = .41$; CIATplus/Related Generalisation: $t = -0.22$, $p = .61$; M-MAT/Related Generalisation: $t = 0.03$, $p = .80$; CIATplus/Unrelated Generalisation: $t = -0.05$, $p = .89$; M-MAT/Unrelated Generalisation: $t = 0.16$, $p = .91$; Related Generalisation/Unrelated Generalisation: $t = 0.09$, $p = .77$). Both the stimuli and verbal productions progressed along a hierarchy of difficulty. *Stimulus complexity* was based on the range of written word frequency of pictured items. The category lists

TABLE 3
Participant selection (pre-treatment) assessment results: CH and MT

	Participant	
Assessment	*CH*	*MT*
Aphasic Depression Rating Scale		
(ADRS; Benaim et al., 2004)/32 [a]; <9 [b]	1	1
Apraxia Battery for Adults (ABA; Dabul, 2000)	Mild-Moderate	Moderate
Apraxia of Speech	Mild	Moderate
Limb Apraxia		
Test of Oral and Limb Apraxia (TOLA; Helm-Estabrooks, 1992): Gestured Pictures [c]	10	6
Proximal Limb/15	7	4
Distal Limb/15	8	5
Oral/15	25	15
Total/45		
A Simplified Hand Preference Questionnaire (Bryden, 1982)	0.7	+1 (Extreme
−1 to +1; >0.6	(Right-handed)	right-handed)
Coloured Progressive Matrices		
(Raven, Court, & Raven, 1995)/37 [d]	24	21
Rey-Osterreith Complex Figure Test		
(Rey, 1941; Osterreith, 1944; as cited in Fastenau, Denburg, & Hufford, 1999)/18 (scaled score); >10		
Copy	4	3
Recall	4	3
Pyramids and Palm Trees Test		
(Howard & Patterson, 1992): 3 Pictures/52; >46	45	35
Psycholinguistic Assessments of Language Processing in Aphasia 53 (PALPA 53; Kay, Lesser, & Coltheart, 1992)/40		
Spoken Picture Naming	**	9
Written Picture Naming	**	4
Repetition	**	39
Reading	**	14
Writing to Dictation	**	6

[a] Maximum score obtainable. [b] Cut-off for scores within the normal range (where applicable). [c] MT's results for this test are likely to be in part confounded by cognitive impairment; TOLA means and standard deviations: Proximal Limb—14.9, 0.4 Distal Limb—15.0, 0.0 Oral—14.6, 0.8 Total 44.5, 0.9.
[d] Raven's Coloured Progressive Matrices percentiles: score of 24 = 50th percentile; score of 21 = 35th percentile, ** Participant unable to complete these assessments due to linguistic deficits.

for each phase were rearranged such that items were grouped together in sets of 13–14 items according to frequency rather than category. The sets were introduced in order of highest to lowest frequency items in each treatment phase to facilitate successful word retrieval. *Syntactic complexity* spanned across two levels ((1) target word in isolation, (2) carrier phrase + target word; see Appendix B). In order to sustain the participants' interest and motivation during the intensive treatment programme, the activities (and carrier phrases, following the introduction of Level 2) were interchanged at 30-minute intervals. In addition, participation awards (store gift cards)

were given to both participants at the completion of CIATplus and half way through M-MAT.

Procedure

CIATplus. A cardboard visual barrier (approximately 35×49 cm) was placed between the participants; it was temporarily removed when necessary based on the activity (for example, during the Board Game when the die was rolled). Participant hand movements behind the barrier were neither inhibited nor encouraged on the basis of aforementioned findings (Morsella & Krauss, 2004; Rauscher et al., 1996) that constraining gestures interferes with naming in healthy speakers. The CIATplus cueing hierarchy is outlined in Appendix C.

M-MAT. The M-MAT cueing hierarchy is outlined in Appendix D. As the treatment objective was to facilitate spoken naming rather than multi-modality communication, the first step of the cueing hierarchy entailed verbally naming the items. The gestures for the items were suggested by the clinicians, and were generally iconic (portraying a concrete action/object) (McNeill, Levy, & Pedelty, 1990). In the drawing step the participants were encouraged to make a simple drawing of the item. In the writing step the entire word was shown initially; over time, the clinicians began to reduce the amount of cues provided.

CIATplus and M-MAT home practice. As part of a simple home programme participants were assigned individualised transfer tasks including one or more items exposed during each session. This involved making a request for an item (e.g., in a local shop) or naming an item in a functionally relevant setting (e.g., during meal preparation at home). The participants were then encouraged to discuss their experiences in the following treatment session.

Data analysis

Standard case charts for each participant were created showing results of naming probes across phases. The presence of significant differences in naming probe results and changes in standardised language tests were explored with a series of non-parametric McNemar's tests. Effect sizes were calculated on naming probe scores using Busk and Serlin's (1992) method of estimating treatment effect size in single-case experimental designs and interpreted according to the Beeson and Robey (2006) classification for aphasia. Comparison of pre, mid, and post discourse measures (Cinderella Story Re-tell; 20-minute conversation; see Appendix E) were analysed with descriptive statistics.

Reliability testing

Inter- and intra-rater reliability was investigated using a random selection of 20% of the naming probe data recordings. Following a time lapse of over 8 weeks between the rating occasions, the first author re-scored 10% of her initial assessments, and the first and third authors each re-scored 5% of one another's assessments of the participants' responses. The first author calculated point-to-point inter- and intra-rater reliability by dividing the total number of agreements by the total number of agreements plus disagreements and multiplying by 100.

RESULTS

Point-to-point intra- and inter-rater agreement was found to be 99.72% and 99.44%, respectively.

The relative efficacy of CIATplus and M-MAT for improvement of noun retrieval in people with severe chronic Broca's aphasia

CIATplus (CIATplus-treated items). Standard case charts showing the results of naming probe assessments are presented in Figures 1 and 2. During the pre-treatment assessment sessions low variability (less than 8%) was demonstrated for both participants. Visual inspection of Figures 1 and 2 reveals that both CH and MT made improvements in picture naming during the 8-day CIATplus programme. Untreated M-MAT items remained stable throughout the CIATplus treatment for CH, while MT showed a small improvement (an average of approximately eight items).

CH demonstrated significant improvement in naming post CIATplus (refer to Table 4) with a small to medium effect size ($p = .001$, $d = 6.33$), and maintenance of treated items at the 6-week follow up ($p = .20$, $d = –4.62$), though not at 3 months ($p = .05$). For MT (refer to Table 5), the improvement post CIATplus and beyond was

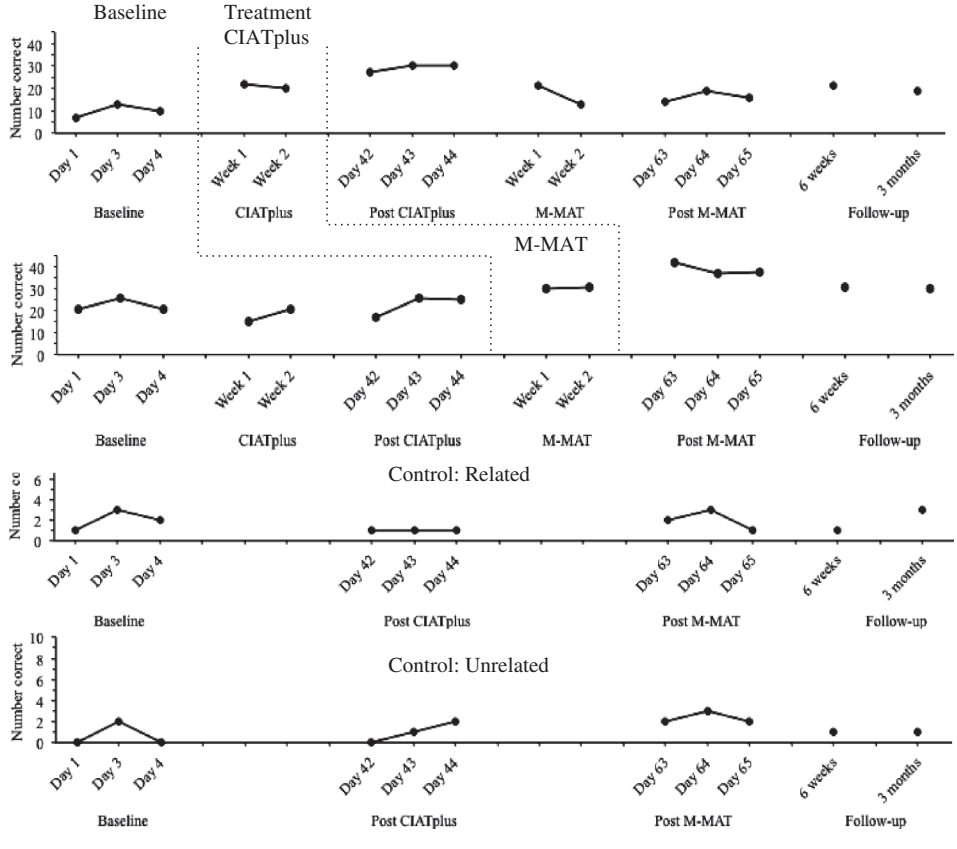

Figure 1. Comparative baseline, treatment and follow-up probe results for CH.

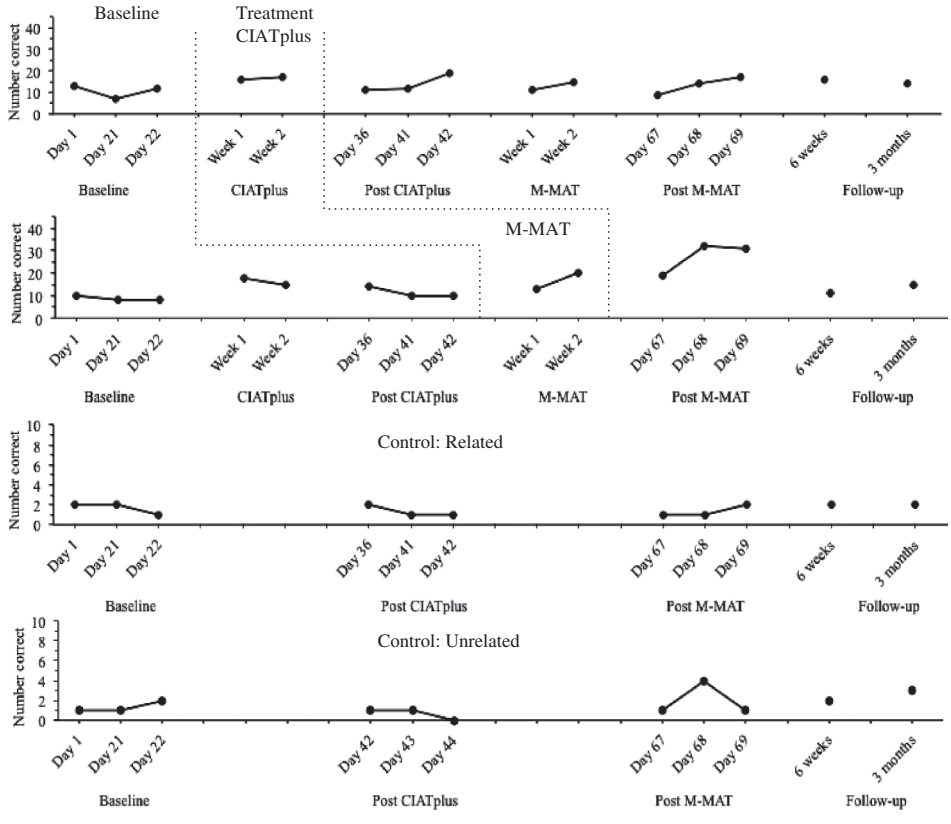

Figure 2. Comparative baseline, treatment and follow-up probe results for MT.

not statistically significant (post CIATplus Day 42, 43, 44: $p = .20$, $d = 1.04$; 6 week follow-up: $p = .50$, $d = 0.46$; 3 month follow-up: $p = .50$, $d = 0.00$).

M-MAT (M-MAT-treated items). Taking a more conservative measure, we utilised the post-CIATplus assessment points as the adjusted "baseline" phase for the M-MAT-treated items. These points show low variability (Figures 1 and 2; less than 12%) for both participants. Improvement in picture naming was evident for both participants during the 8-day M-MAT programme (see Figures 1 and 2: M-MAT Week 1, 2). During this time, CH's accuracy in naming CIATplus-treated items reduced by an average of approximately 12 items, with MT demonstrating overall maintenance of skill. This suggests that there was no leakage from the M-MAT training to the CIATplus items.

Compared with post-CIATplus scores, the M-MAT treatment led to an overall significant increase in naming accuracy post M-MAT for both participants (CH: Table 6; MT: Table 7). M-MAT led to significantly improved immediate post-treatment scores with small to medium effect sizes for both participants (CH: $p \leq .02$, $d = 4.27$; MT: $p = .001$, $d = 4.53$). Maintenance of treated items at the 6-week and 3-month follow-ups was seen for CH only (6 weeks: $p = .30$, $d = 2.18$; 3 months: $p = .10$, $d = 1.92$).

General observations. Considering the overall amount of change from initial baseline to post-treatment scores, significant changes were found for both participants

TABLE 4
McNemar's Test scores and effect sizes for CIATplus Probes: CH

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[a] 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

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.

[a]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 5
McNemar's Test scores and effect sizes for CIATplus Probes: MT

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[a] 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	.50	0.00

Pre-Tx = Pre-Treatment; Post-C+ = Post-CIATplus; McN. = McNemar's score; shaded value denotes the immediately post-CIATplus effect size.
[a]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 6
McNemar's Test scores and effect sizes for M-MAT Probes: CH

Post CIAT+ 1 vs. Post M 1		*Post CIAT+ 2 vs. Post M 2*		*Post CIAT+ 3 vs. Post M 3*		*Baseline[a] vs. Post M*	*Post M 3[b] vs. 6 wks*		*Baseline[a] vs. 6 wks*	*Post M 3[b] vs. 3mo.*		*Baseline[a] 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

CIAT+ = CIATplus; Post-M = Post M-MAT; McN. = McNemar's score; the shaded value denotes the immediately post M-MAT effect size; *, statistically significant positive change; **, statistically significant negative change.

[a]"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). [b]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 7
McNemar's Test scores and effect sizes for M-MAT Probes: MT

Post CIAT+ 1 vs. Post M 1		*Post CIAT+ 2 vs. Post M 2*		*Post CIAT+ 3 vs. Post M 3*		*Baseline* [a] *vs. Post M*	*Post M 3* [b] *vs. 6 wks*		*Baseline* [a] *vs. 6 wks*	*Post M 3* [b] *vs. 3mo.*		*Baseline*[a] *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

CIAT+ = CIATplus; Post-M = Post M-MAT; McN. = McNemar's score; the shaded value denotes the immediately post M-MAT effect size; *, statistically significant positive change; **, statistically significant negative change.

[a]"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). [b]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.

for both sets of treated items (CH, CIATplus: $d = 6.33$, M-MAT: $d = 4.27$; MT, CIATplus: $d = 1.04$, M-MAT: $d = 4.53$). While expected for CH (due to observed change following both treatments), this suggests that, for MT, the combined effect of the treatments was substantially greater than the effects of either treatment alone. Stable results in untreated semantically related and unrelated items point to the specificity of the demonstrated treatment effects of CIATplus and M-MAT, discounting possible effects from general stimulation or other non-treatment factors.

Generalisation to discourse

Relevant features of discourse tasks (e.g., on-target, specific nouns and verbs; mean on-target, specific nouns per minute, etc.) are shown in Table 8. No statistically significant improvement was found in the discourse analyses from either participant. However, qualitatively in the picture description from the Western Aphasia Battery, the accuracy of noun production (specific and on-target) increased for CH (e.g., "branch" → "tree") following CIATplus. MT's noun relevance during the picture description was observed to increase slightly (pre treatment: e.g., *sky, sea*, *shoes*; post CIATplus: e.g., *tree*, *girl*), and was maintained at the post-M-MAT and 6-week follow-ups (e.g., *house*, *dog*). The relevance of nouns increased further at 3 months (e.g., *yard*, *father*, *mother*, *picnic*)—accurately representing the picture's central theme. Analysis of the semi-structured conversation showed that CH's noun use had decreased following CIATplus, and increased following M-MAT. However, this was not well maintained at the follow-up points. A small increase in MT's noun use was observed following M-MAT, although this reduced to just below baseline level at the post-M-MAT assessment. Finally, for the Cinderella narrative CH was unable to produce a verbal or nonverbal response following CIATplus. At post M-MAT she drew stick figures to depict two storybook scenes, and used some appropriate speech fragments and gesture ("yuck" and pointing) to indicate that one of the characters was evil. MT did not use any of the five treated items (*mouse*, *pumpkin*, *slipper*, *shoe*, and *clock*) that may be considered relevant to the Cinderella story (see MacWhinney, Fromm, Holland, Forbes, & Wright, 2010) across the assessment sessions. Notably, her response following M-MAT comprised a clearer discourse structure, which was not the case at the pre-treatment or post-CIATplus assessments. MT's Cinderella samples taken at pre-treatment, Post CIATplus and Post M-MAT are shown in Appendix F.

Standardised measures of language impairment

Pre- to post-treatment results for the following measures are summarised in Table 8.

Western Aphasia Battery. A 5-point change on the WAB Aphasia Quotient (AQ) has previously been argued to be clinically significant (Katz & Wertz, 1997). Neither participant showed such a change immediately following CIATplus or M-MAT, or overall between pre and post treatment. However, a clinically significant increase in CH's WAB AQ was found from pre treatment to the 6-week and 3-month follow-up sessions. In addition, MT's WAB AQ at the 3-month follow-up was significantly greater than all of the other assessment phases by between 21 and 26 points, resulting in her aphasia severity being reclassified as moderate. Aside from CH's improvements in some areas of naming and word finding, the bulk of WAB AQ change at these time points can be attributed to increases on the Auditory Comprehension and Repetition

TABLE 8
Comparison of pre-treatment, post-CIATplus/inter-phase interval, and post-M-MAT assessment results: CH and MT

	CH					*MT*				
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, et al., 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 et al., 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										
Word Fluency/20	16	23	25	33	29	24	26	20	20	28
Sentence Completion/10	0	6	6	7	7	0	0	0	1	2
Responsive Speech/10	4	5	4	5	5	7	5	8	8	8
Spontaneous Speech—Picture Description:	1	4	4	2	2	2	2	2	4	7
Information Content/10										
Fluency/10	3	2	3	5	3	3	4	6	6	6
On-target, specific nouns	2	2	2	2	2	5	5	5	5	5
Mean on-target, specific nouns per minute (NPM)	4	5	3	4	11	3	2	2	2	4
	2.33	1.88	1.29	1.0	1.48	1.09	0.86	1.50	0.82	2.23
Scenario Test (van der Meulen et al., 2010) /54	33	36	37	45	42	31	39	36	38	39
Cinderella Narrative Retell			Not available							
Mean words/minute (WPM)						88	106	126	126	128
% Correct Information Units [a]CIUs; Nicholas & Brookshire, 1993)						44%	45%	51%	31%	46%

(*Continued*)

TABLE 8
(Continued)

	CH					MT				
Assessment	*Pre tx*	*Post C+*	*Post M*	*6 Wk.*	*3 Mo.*	*Pre tx*	*Post C+*	*Post M*	*6 Wk.*	*3 Mo.*
Mean CIUs/minute						39	48	64	38	59
On-target nouns (including non-specific[c])						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 (see Appendix E for pro forma) [d]										
On-target, specific nouns	8	5[e]	13[f]	8	4	23	27	22	25	22
Mean on-target, specific nouns/minute [g]	–	–	–	–	–	1.81	1.93	2.0	1.86	1.52
On-target, specific verbs	2	0	1[h]	0	0	15	12	10	13	13

Pre tx = Pre treatment; Post C+ = Post CIATplus; Post M = Post-M-MAT; 6 Wk. = 6 week follow-up; 3 Mo. = 3 month follow-up.
[a]Correct Information Unit analysis allows measurement of the informativeness and efficiency of utterances. [b]See main text for further on CH's Cinderella Retell responses. [c]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. [d]Length of conversations: CH—5.5 minutes; MT—20 minutes. [e]Includes a noun (porridge) cued with the first syllable by the conversation partner. [f]Includes three nouns (proper names) cued with the first sound by the conversation partner. [g]CH's mean number of nouns per minute for the Semi-Structured Conversations has not been calculated due to her limited verbal output. [h]Verb (reading) cued with the first sound by the conversation partner.

subtests. McNemar's test scores for the Western Aphasia Battery—Object Naming section are shown in Table 9.

Boston Naming Test. As outlined in Table 9, no statistically significant improvements were found for either participant on the BNT following CIATplus (CH, $p = .344$; MT, $p =$ n/a) or M-MAT (CH, $p = .109$; MT, $p = .062$). However, CH's score improved significantly from pre treatment to post M-MAT, indicating an overall treatment effect on this naming task. Both participants' scores fluctuated between the 6-week and 3-month follow-up points (see Table 8); at the latter CH's score was almost at post-M-MAT level, while MT's score had decreased to 0.

Communicative effectiveness

Communicative Effectiveness Index. As in the study by Code, Torney, Gildea-Howardine, and Willmes (2010), the "critical difference" of 1 *SD* (12.36 points) was used for the CETI to determine the presence of significant treatment effects. The total CETI score post CIATplus increased for both participants (see Table 8). The post-CIATplus to post-M-MAT CETI scores increased by 9 points for CH and 8 points for MT. As demonstrated by a comparison between pre treatment and post M-MAT, the general effect of treatment translated to an increase of 12 points for CH (just less than the critical difference) and 9 points for MT. While *overall* scores did not reach the level of critical difference, some *individual* test items did.

Scenario Test. The Scenario Test (van der Meulen et al., 2010) is a new test that focuses on the participant's ability to communicate actions and ideas as related to a set of pictured everyday scenarios (e.g., buying and trying on clothes in a store; ordering a taxi) using speech, drawing, or gesture with or without examiner support. The test has a maximum score of 54, excellent test–retest reliability (ICC = 0.98, $p < .001$) and is sensitive to change. Analysis of the participants' results (see Table 8) involved a comparison of the different modalities used, as well as the type and degree of assistance required from the communication partner. The degree of verbal (spoken and written) and alternative (gesture and drawing) communication that CH used following CIATplus remained unchanged, while MT improved 8 points post CIATplus, demonstrating her highest score of the series. Following M-MAT, CH's score improved 4 points, reflecting increased intelligibility of gesture and drawing. The 6-week follow-up marked CH's largest improvement of 12 points (compared with pre-treatment), based on an increase in her use of oral and written communication and her effective use of drawing. Both MT's follow-up scores approximated her post-CIATplus achievement.

Quality of life

Both participants' pre-treatment scores were high (within 2 *SD* above the mean for people with aphasia) for both assessed domains of the SAQOL-39 (see Table 4). CH's scores were maintained at post M-MAT. The meaningful negative QoL changes of 1 *SD* at 6 weeks post treatment for CH and at post M-MAT for MT are likely due to reported changes in social routine and health issues; their scores restabilised at follow up (CH: 3 months, MT: 6 weeks). By the 3-month follow-up MT's Communication score had increased to within 2 *SD* above the mean.

TABLE 9
McNemar's Test scores for Boston Naming Test and Western Aphasia Battery—Object Naming: CH and MT

	Pre tx vs post CIAT+				*Post CIAT+ vs post-M-MAT*				*Pre tx vs post M-MAT*			
	CH		*MT*		*CH*		*MT*		*CH*		*MT*	
Assessment	*McN.*	*p*	*McN.*	*p*	*McN.*	*p*	*McN.*	*p*	*McN.*	*p*	*McN.*	*p*
Boston Naming Test	1.5	.344	0	n/a	4.17	.109	6.25	.062	4.9	.05**	3.2	.188
Western Aphasia Battery—Object Naming	0.9	.50	3.2	0.188	0.125	.637	4.17	.016*	0.8	.812	0	n/a

Pre Tx = Pre treatment; CIAT+ = CIATplus; McN. = McNemar's score; CH's values are shaded to facilitate ease of reading; *, statistically significant positive change; **, statistically significant negative change.

Participant evaluation of treatment experience

Both participants reported feeling that their communication had improved following each treatment. MT stated that she preferred M-MAT to CIATplus as M-MAT allowed for more opportunities to communicate the stimulus items to her partner, and she felt as though she knew more words (resulting in less frustration than during CIATplus). In addition, MT expressed that, although it was hard work, she found M-MAT more interesting and enjoyable than CIATplus.

DISCUSSION

This pilot study constitutes the third known direct comparison between constraint-induced and multi-modality therapy approaches for anomia. Its addition to the literature provides further insight into the existing topical research issue concerning constraint-induced aphasia therapy. However, the interpretation of comparisons between the findings from the present and previous studies should be made carefully due to the heterogeneous nature of the samples studied previously, along with the differing treatment methods applied.

Treatment efficacy: Treated stimulus items

In this study the focal definition of treatment efficacy related to improvement in picture-naming accuracy of trained items immediately post treatment and at the 6-week and 3-month follow-ups, as well as the magnitude of the overall treatment effect sizes. The findings were not wholly consistent with the first hypothesis (that both CIATplus and M-MAT would lead to significant improvements), as CIATplus led to varying degrees of immediate acquisition and maintenance. While M-MAT was consistent for immediate acquisition, it resulted in different maintenance results for each participant. *Overall, M-MAT proved either comparable or superior to CIATplus.* A plausible explanation for this finding is the varied cognitive processes underpinning the two treatments, which in turn positively impact on neuroplasticity and learning in chronic aphasia. 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 one another) has been explored in the historical (e.g., Luria, 1973; Paivio, 1986) and more recent neuroscience literature (Jirak, Menz, Buccino, Borghi & Binkoski, 2010; Miller, 2006; Pulvermuller & Berthier, 2008). CIATplus may lack the enrichment processes central to the numerous neural networks activated through M-MAT for some participants, thus leading to less-effective outcomes.

Between the later part of M-MAT treatment and post-M-MAT assessment points, both participants demonstrated large increases in naming response scores; this is consistent with Code and colleagues' (2010) findings with a standardised measure. We speculate that a slightly delayed effect of the M-MAT treatment led to the naming gains found post M-MAT at follow-up. This may also explain CH's maintenance of M-MAT items (and not CIATplus items) at the 3-month follow-up. The mechanisms of such phenomena should be further explored.

The findings with respect to effect sizes supported the second hypothesis (that there would be no significant difference *between* improved naming scores for items trained

in CIATplus as compared to M-MAT) in that both treatments were comparable for CH for immediate gains. However, M-MAT proved superior for CH for naming skills maintained up to the 3-month follow-up, as well as for MT in generating immediate positive change. These results are aligned to the suggestion that multi-modality treatment may be equally as effective as constraint-induced options (e.g., Kurland et al., 2010; Maher et al., 2006). The clinical implications of this finding will be discussed further below.

Treatment efficacy: Other measures

In relation to communicative effectiveness, both participants showed improvement on the Scenario Test, and item-specific—yet not statistically significant overall—improvement on the CETI. The latter finding contrasts with a previous CIAT versus CIATplus comparison (Meinzer et al., 2005), where both treatments resulted in improvements on this measure. However, Meinzer and colleagues (2005) used repeated-measure ANOVAs to confirm significant improvements in CETI scores. As raw scores were not provided in the results, it is not possible to determine if the change in scores after treatment met minimal meaningful difference thresholds (12.3 for the CETI as used in our study) or clinically meaningful levels. Notably, when these constraint-induced results were compared with another multi-modal intervention (Model Oriented Aphasia Therapy), the latter led to greater gains (Barthel et al., 2008). In support of this research, both participants in the present study showed more item-specific improvements on the CETI following M-MAT than CIATplus.

The lack of change in QoL by the end of treatment may have been due to the relatively short duration of therapy, as well as the significant aphasia severity and chronicity of the participants. Longitudinal research may better account for changes in QoL throughout the rehabilitation of aphasia. Despite this null finding, each participant viewed both treatments in a positive light. However, the frustration experienced by MT during CIATplus mirrors a report from the CIAT versus PACE study (Maher et al., 2006). The fact that MT preferred M-MAT over CIATplus reinforces the notion that along with measures of both impairment and functioning, participants' views of treatment are relevant to the evaluation of treatment efficacy.

Generalisation

Generalisation failed to occur for untrained items, both within and across semantic categories; this is consistent with results from a similar study by Kurland and colleagues (2010). However, the results contrast with several alternative modality (as opposed to *multi*-modality) studies where naming has carried over to related items and some unrelated items. Considering the supposed increased potency of multi-modal treatment, it is possible that participant differences (e.g., severity of aphasia) between the former and present studies have influenced this disparity.

Both participants evidenced gains for only one of the three measures of discourse utilised, with the most gains having occurred following M-MAT. CH's outcome parallels results of conversation found in a constraint-induced-related study (Faroqi-Shah & Virion, 2009) and an alternate modality study (Rose et al., 2002). However, MT's outcome contrasts with the majority of Cinderella narrative outcomes in the literature, where CIAT has led to retell improvement in isolation (Szaflarski et al., 2008) and more so than its multi-modal counterpart (Maher et al., 2006).

Neither participant demonstrated improvements for the WAB AQ or the BNT immediately following either treatment. Previous findings have been inconsistent for CIATplus—no change in AQ (Berthier et al., 2009); increased AQ (Faroqi-Shah & Virion, 2009; Maher et al., 2006). In the alternative modality research AQ increases have been shown for participants with mild and moderate aphasia (Rose & Douglas, 2008; Rose et al., 2002; Wright et al., 2008). In relation to the BNT our findings are generally consistent with previous literature (e.g., Raymer et al., 2006; Wright et al., 2008).

Improvements were found in both participants' WAB AQ scores occurring at the 6-week (CH) and 3-month (CH and MT) follow-up assessments. The finding that the majority of change on the AQ was not primarily related to improvements in Naming and Word Finding subtests was consistent with a combined gesture/verbal treatment (Raymer et al., 2006), where gains were mainly attributed to increases in auditory comprehension. Results of other studies (e.g., Berthier et al., 2009; Wright et al., 2008) show immediate increases in non-naming areas in *conjunction* with improvements in Naming and Word Finding subtest scores. The participants' gains at maintenance reinforce the improvement in overall group comprehension skills and "delayed effect of treatment" theory reported by Code and colleagues (2010).

Considerations regarding participant characteristics

Although the interacting impacts of characteristics including aphasia severity and cognitive impairment are not clear, it is highly likely that the co-morbid cognitive differences (Lambon Ralph et al., 2010; van de Sandt-Koenderman et al., 2008) between CH and MT account for at least some of the variance in the participants' responses to treatment.

The roles of verbal constraint and treatment intensity

In relation to naming responses to probes, both participants made gains following M-MAT (and MT following M-MAT alone). Therefore our results reinforce the existing notion (e.g., Barthel et al., 2008; Kurland et al., 2010; Maher et al., 2006) that constraint is unlikely to be crucial for effective anomia therapy in chronic aphasia. There is a strong suggestion that intensive treatment programmes result in greater gains than non-intensive options (Bhogal, Teasell, & Speechley, 2003). As in previous research (e.g., Barthel et al., 2008; Maher et al., 2006), the participants responded differently to each intensive treatment, confirming that intensity is not the *only* factor contributing to aphasia treatment efficacy. It is speculated that, along with treatment type, an interaction between participant characteristics and the length of intensive treatment may exist, and warrants further investigation. For instance, Bhogal and colleagues found that approximately 9 hours of therapy for 11 weeks led to significant treatment effects, while Rose and colleagues (Rose & Douglas, 2008; Rose et al., 2002) reported improvements following much shorter intensive programmes—these values were likely influenced by the treatment type(s) and participant characteristics present.

Clinical implications

Several clinical implications result from this study's preliminary findings. First and foremost, it seems 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. Second, as constraint does not seem crucial with intensity controlled, applying multi-modal treatment such as M-MAT in the clinic appears an option. Finally, in contrast to constraint-induced treatment, M-MAT takes a rich, multi-sensory/motor approach that can be more enjoyable both to undertake and to conduct. These clinical implications must be viewed in light of several methodological limitations.

LIMITATIONS AND FUTURE DIRECTIONS

Given the limitations imposed by early pilot work utilising detailed single-participant designs, we employed an alternating treatments protocol. Future studies using crossover designs with larger numbers of participants would allow for a clearer evaluation of the possible influence of treatment order effects. However, in this study treatment order effects were carefully monitored through the application of multiple baselines.

Future studies could consider extending the role-play scripts to reflect a longer interaction, and adapting the protocol to apply a greater focus on discourse-based tasks to encourage generalisation. Tasks to promote transfer *during* therapy contact could also be considered. Finally, neuroimaging could be utilised in order to further understand the mechanisms of therapeutic change (e.g., Kurland et al., 2010; Menke et al., 2009).

CONCLUSIONS

The results of this preliminary study indicate that noun retrieval during picture naming was temporarily enhanced using M-MAT with two individuals with severe chronic Broca's aphasia. M-MAT was more efficacious than CIATplus for naming improvements in the participant with greater cognitive deficit, as well as for overall maintenance of naming gains. Participant evaluation of the interventions was more positive for M-MAT than CIATplus, and participants were satisfied with their treatment. Supporting the potential potency of multi-modality treatment, these findings contribute to the developing suggestion that constraint-induced treatment is not necessarily the only evidence-based choice for rehabilitation of severe chronic anomia. With methodologically stronger research in this area, clinical decisions regarding treatment for patients with aphasia will be better informed.

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APPENDIX A

Response scoring criteria

(1) Participant (P) states correct name for item but says something such as, "no . . . "
  Does not choose another name afterwards → CORRECT
  Chooses *another* name afterwards → INCORRECT
(2) P communicates the name for item using an alternative modality
  Names the item in the spoken modality before or afterwards → CORRECT
  Does not name the item in the spoken modality → INCORRECT
(3) P states correct name for item within a compound word, phrase, or sentence (e.g., "shoelaces" for "shoe", "go to the toilet" for "toilet")
  If assessor reminds P to name item and P *names item* alone; the response does not dramatically alter the meaning of the word (e.g., "field mouse" for "mouse") → CORRECT
  The meaning of the item has been changed; P shows *no awareness* of having said item or *is unable to name item* alone → INCORRECT
(4) P states the name of an item after that picture has been turned over
  Picture has *not yet been laid down*/attempts at naming of the next item *has not commenced* → CORRECT
  Picture has been *laid down*/attempts at naming of the next item *has commenced* → INCORRECT
(5) P states the name of an item in the form of a verb (e.g., "ironing" for "iron") → INCORRECT
(6) P states correct name for item but in plural form (e.g., "sandwiches" for "sandwich")
  → CORRECT
(7) P states name for item with phonemic paraphasia
  Word *remains guessable* and is not ambiguous in meaning (e.g., /pəskɛtI/ for spaghetti; /kɔ:rkstru/ for corkscrew) → CORRECT

Word is *no longer guessable* or has taken on the form of *another word*—whether or not it exists in the treated body of stimuli (e.g., /sta:f/ for scarf; /lɒk/ for clock; /tæp/ for cap) → INCORRECT

(8) P states name for item which is not the one on the probe score sheet / not the one already trained in therapy

Name is a *reasonable alternative* name for items (e.g., pullover for jumper; bug for beetle; beaters for mixer; loo for toilet; father for priest—as the alternative "father", i.e., to a child would be unlikely to be pictured clearly) → CORRECT

Name is *ambiguous* (could mean other things, e.g., fag/smoke for cigarette/cigar) → INCORRECT

Name is *not the best description* based on the picture (e.g., pope for priest) → INCORRECT

(9) P states name for item which is not the one being trained in therapy

Name is a *reasonable alternative* name for items (e.g., pullover for jumper; bug for beetle; beaters for mixer; loo for toilet → CORRECT

APPENDIX B

TABLE B1
Stimulus and syntactic complexity levels (adapted from Kirmess & Maher, 2010)

Level	*Syntactic complexity*	*Example target*
1	Noun	"Couch?"
2	Carrier phrase[1] + noun	"Do you have a couch?"

[1]The carrier phrases were: "Do you have a . . . ", "I want/need a . . . ", and "I bought/saw/have a . . . ". The participants were encouraged to produce accurate carrier phrases with as much support as required, although incompleteness and/or incorrect use of morphology was accepted if the noun was correct.

APPENDIX C

TABLE C1
CIATplus cueing hierarchy—Example for Level 1

Step	*Description*
1	Participant verbally names item[1] (e.g., "couch"). If correct, move on to next card (starting at Level 1, Step 1 again) following partner's turn to name item. 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[2] (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.

[1]The participants were given up to 10 seconds to respond at each step. [2]The written cues were presented in the same card format as the stimulus items (the text was word processed in Arial Black font with the card in landscape orientation).

APPENDIX D

TABLE D1
M-MAT cueing hierarchy—Example for Level 1[1]

Step	*Description*
1	Participant verbally names[2] item (noun; e.g., "couch"). If correct, move on to next card (starting at Level 1, Step 1 again) following partner's turn to name item. If incorrect, go to Step 2
2	Ask participant to make an iconic gesture[3] and say the word to name the pictured item. If item named, move on to next card following partner's turn. If incorrect, go to Step 3
3	Clinician provides an iconic gesture model[4]. If item named, move on to next card following partner's turn. If participant unable to name item, clinician provides item name and asks participant to repeat with gesture. Then go to Step 4
4	Ask participant to make a drawing[5] and say the word to name the pictured item. Clinician provides refinement cues as necessary. Then go to Step 5
5	Clinician provides a written model[6] (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.

[1]At Level 2 the carrier phrase was required in spoken form only. [2]The participants were given up to 10 seconds to respond at each step. [3]Any approximation of the gesture was positively reinforced by the clinicians. [4]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. [5]Any drawing which highlighted the characteristic features of the item was positively reinforced. [6]The written cues were presented in the same card format as the stimulus items (the text was word processed in Arial Black font with the card in landscape orientation).

APPENDIX E

Semi-structured conversation pro forma[1]

(1) What have you been doing today?
(2) Can you tell me about your stroke?
(3) Can you tell me about your family?
(4) How did you and your partner meet?
(5) Can you tell me about your friends?
(6) Tell me about your pets (if you have any)—or what pet you would have if you could (and why)
(7) What sort of work have you done in your life? What has been your favourite and why?
(8) Can you tell me about your home and/or garden? How did you come to live here?
(9) What are your hobbies/interests? How did these develop?
(10) What kinds of foods/restaurants do you like?
(11) What sorts of music do you like and why? Have you ever learned to play a musical instrument?

[1]As CH's conversation was of reduced length, her conversations generally pertained to questions 1–3.

APPENDIX F

MT's Cinderella retell transcriptions

Pre treatment

MT: She was um really annoying what do you say . . . and she was um really . . . .was um really good . . . she was a . . . she was going to be all right but um sh-she said "No, nothing here" . . . and then . . . .um . . . mm...and at the end she sa-says "I'm going to be to this" um . . . then it was good, 'cause ah they had a um it was a um . . . mmm *(icv gesture)* and then they were going to be in . . . oh . . . at the end i-i-i-it was really good know she was there and she had a /hɜn/ *(jargon)* and h- er and our was uh a . . . boy too. So that was it.

Post CIATplus

MT: Well we first of all we were at our . . . it was a s—uh story, and I had t—one of them, very very nice but the others were really bad, and it was . . . .everyone was doing everything /fai/ by(?) me, you know, b—uh, me but I wasn't doing it. And then all of a sudden, they said, "Oh, what's /nɔ/—uh . . . that's good". But the—the other—uh the . . . the . . . wo—wo—*(points to the fairy godmother on the cover of the book)* woman, said "Oh, that's lovely, you've got something very nice." And then all of a sudden this one *(points to Cinderella on the cover of the book)* said "Oh, very very nice!" *(gestures to her clothing)*. And then . . . um . . . then they said "Why /wɛ/ be very nice have /aem/ a beautiful um thingabob". And all of a sudden they said, "No, that's wrong" because they were really bad, and then they said . . . at the end, "No", these people they're not (?got) two of them they were very bad. And the other one was, "Oh, hello, how are you?" and everything and it was a *(points to the bottom of Cinderella's dress on the cover of the book, and appears to gesture to her shoes—potentially referring to the glass slippers)* a beautiful thing . . . /^ɛ/ . . . and then that was the end of that.
Interviewer: And so what happened in the end?
MT: Uh she and him go out, and say l—lovely. That's it.

Post M-MAT

MT: Well there was a /d^/ a girl, and she said, "I'm going to the ball". But not ah two of them. Ah one two. Uh and uh and then there's partner said, "Oh, all of them are going to the /pa:/—the party." And I said to her, "Oh yes?" and then they said "Would we like to to it too?" And she said, "No." Then ah . . . and then there um there was something and I said, *(points to Cinderella on the cover of the book)* "I want to go to the party." But then /s^n/–/s^ndərɛll^/ said "Oh, this one" *(points to Cinderella on the cover of the book)* and uh um um ah all the uh /peI/ uh people uh no, there this one *(makes a transverse circular motion)* is a big one, and she said "I like it if I could /doʊ/ to the party." /sioʊ/ she said to *(points to the Fairy Godmother on the cover of the book)* her, "Would you like to have a um um thing done?" So I said, "Yes, I want to go to the ball." So and and there was a um thingabob that was uh um very good one, and she said, "Okay, we'll go to the ball." And I *(referential gesture)* was very very nice and then all of a sudden /ʃ/ *(points to self)* uh and then there was *(gestures in front of her)* some things there that were all right, and then all of a sudden they were wrong. And they said, "Why?" Ah because it was um . . . it was very bad.

And all of a sudden, um they said "Oh, there's one *(referential gesture)* that um, uh uh um . . . oh then the no—then they said "Would you like to have a partner?" and everything like that, and then it was um they were /boʊ/ uh embarrassed because it was no good anymore. So then they said, "There's something else?" and they said, "No, there's nothing wrong with it." *(referential gesture)* And all of a sudden they said, "Oh, there's another one and were very good" So she eh ah so she said "Do you have a thingabob?" And I said "Yes, there's something *(referential gesture)* there." And then the end, they said "Oh, it's a good—it's a it is a . . . two of them *(referential gesture),* they were going to marry. So that's the end.