Introduction

Verb production problems are an extremely common and pervasive aphasic deficit following stroke (Thompson, 2001). They can be characterized as two main types: difficulties in accessing verb word forms (verb access impairment) or difficulties in verb meanings (verb semantics). It is possible that different types of verb impairments will respond differently to specific treatments.

Several recent studies have reported positive acquisition of trained verbs following repetition, semantic and phonological treatments for participants with Broca's aphasia (Bastiaanse, Hurkmans, & Links, 2005; Webster, Morris, & Franklin, 2005) although with limited generalisation. Research is beginning to emerge with outcome measures focused on verb use in discourse rather than the more standard picture naming (Raymer et al., 2007), and is also beginning to address the comparative efficacies of traditional verbal treatments such as semantic, phonologic, and orthographic methods (Raymer & Ellsworth, 2002; Rose, 2006; Schneider & Thompson, 2003; Wambaugh et al., 2001; 2002). It remains unclear exactly which components of various common treatments (e.g., the word repetition step, semantic knowledge, gesture production) contribute to the potency of a particular treatment.

Aims and Hypotheses

This study aimed to investigate the relative efficacy of semantic, word repetition, and gesture treatments for both word form and semantic verb retrieval deficits in Broca's aphasia. We hypothesized that all treatments would lead to significantly enhanced verb production for trained items. Further, we hypothesized that the combined semantic and gesture treatment would be superior for verb word forms (access impairment) deficits. Improved verb production was expected to generalize to picture description and conversational contexts for the treated items but not for novel items.

Method

We report on five single-subject experiments using multiple-baseline across conditions designs. At least three treatment conditions were compared for each participant: semantic, repetition, combined gesture and semantic or gesture alone.

Participants: Five individuals with chronic (>12 months post onset), Broca's aphasia, after single, left-hemisphere strokes, and having verb production deficits arising from impairments at predominantly the semantic (MT) or word form levels (MW; KC; PF; GF), were invited to participate in the study. The type and severity of the verb production deficits were ascertained by the pattern of tests results obtained on a range of standardised speech, language, and cognitive assessments (see Table 1 for details). In addition, measures of verb use were taken in a 20-minute conversation with the researcher and measures of self and close-other perceptions of communicative ability were obtained with the La Trobe Communication Questionnaire (LCQ) (Douglas, O'Flaherty & Snow, 2000).

Procedure: Following the assessments, participants underwent ten baseline sessions where they attempted to name 100 black and white action line drawings. The baseline phase was followed with between 20 to 40 verb therapy sessions. Sessions were approximately 60 minutes long and were held 3 times per week. Following the baseline trials, the 100 action pictures were carefully divided into five sets of 20 items each, balanced on psycholinguistic parameters known to affect verb production abilities (familiarity, syllable length, age of acquisition, presence of homophonous noun, argument structure complexity) (Druks, 2002) and individual error rates. One 20-item set was utilised in each of the treatment conditions and at least one set was kept in a control (untreated) condition. Follow-up verb production trials were completed one and three months after the final treatment session. Standardised testing was re-administered at the completion of the treatment sessions.

Treatment Protocol: Each item was presented with a clinician request to "say what is happening in the picture". Items not correctly produced within 20 seconds of presentation of the picture were scored as 'incorrect' and the response-contingent treatment protocol commenced. The semantic and combined treatment protocols were based on semantic feature analysis methods (Coelho, McHugh, & Boyle, 2000). Participants were asked to say (in the verbal condition), or gesture and say (in the combined condition) an associated object, associated movement (body part) and associated location (where the action is carried out) for each item in error and were provided with models when they could not spontaneously generate the information. If the semantic feature training failed to elicit the correct verb or gesture response, a spoken or spoken plus gesture model was then provided**.** In the repetition condition, participants were simply provided with the spoken word to imitate in the presence of the picture.

Data analysis: All baseline and treatment sessions were videotaped for later transcription and analyses. Inter-rater agreement was investigated by a second rater who scored the participant responses of 20% of all baseline and treatment sessions. Treatment fidelity was investigated by a second rater who checked the application of the treatment protocols in 20% of randomly selected treatment sessions. Standard case charts of each participant's verb naming scores were constructed for initial visual analysis (see Figures 1-5). The presence of significant treatment effects and differences between the treatment conditions were investigated through effect size calculations (Busk & Serlin, 1992). The presence of statistically significant differences in pre-post standardized test scores (VAST; WAB; LCQ) were investigated with a series of non-parametric McNemar's tests. Counts of the total number of verbs produced during picture description and 20-minute conversation were compared pre and post treatment.

Results

The four participants with word form deficits (MW; KC; PF; GF) showed significantly improved verb production on trained items (see Figures 1-5) with moderate to large treatment effects (see Table 2) while control items showed minimal change. For the four participants with word form deficits, generalization of verb production to picture description was demonstrated with modest generalization to conversation tasks (see Table 3). However, the participant with the semantic verb impairment (MT) showed minimal improvement in naming trained items in any condition. Contrary to predictions no clear picture of superiority of one treatment condition over another emerged for any participants. Rather, each participant showed a unique pattern of degree of response to the different treatments. Repetition was the least successful condition overall although PF responded very positively to it.

Discussion

This study adds to the positive treatment efficacy data for chronic, Broca's aphasic verb retrieval impairment of predominantly word-form type. The variable response to treatment conditions demonstrated in these five participants is consistent with our previous preliminary work and warrants more extensive investigation. Although the repetition only condition was the least potent for all but one participant, there was still measurable gain from it. This suggests that repetition as a component of any verb retrieval therapy protocol has some merit, although is probably not as potent as the semantic and gesture components. We believe this idea requires further larger scale careful examination, particularly in the light of PF's extremely strong response to repetition and given he had the mildest aphasia and the strongest non verbal reasoning scores on Raven's Progressive Matrices.

The generalization demonstrated to a small number of untreated items and to discourse tasks is encouraging and inconsistent with many previous studies, although is consistent with models of lexical selection and priming studies that suggest that semantically related items are primed when a target is accessed (Levelt, 1993; Schneider & Thompson, 2003). The poor results obtained for the participant with a semantic deficit argues against a "one size fits all" verb treatment and highlights the significance of deeper language processing abilities and the impact of possible concomitant cognitive impairments on rehabilitation.

References

Bastiaanse, R., Hurkmans, J., & Links, P. (2005). The training of verb production in Broca's aphasia: A multiple-baseline across-behaviours study. Aphasiology, 20,(2/3/4), 298-311.

Coelho, C., McHugh, & Boyle, M. (2000). Semantic feature analysis as a treatment for aphasic dysnomia: A replication. Aphasiology, 14(2), 133-142.

Douglas, J., O'Flaherty, C., & Snow, P. (2000). Measuring perception of communicative ability: The development and evaluation of the La Trobe communication questionnaire. Aphasiology, 14, 251-268.

Druks, J. (2002). Verbs and nouns: A review of the literature. Journal of Neurolinguistics, 15, 289-315.

Levelt, P. (1993). Language use in normal speakers and its disorders. In G. Blanken, J. Dittman, H. Grimm, J. Marshall, & C. Wallesh (Eds.), Linguistic disorders and pathologies (pp. 1-15). Berlin: Walter de Gruyter.

Raymer, S., & Ellsworth, T. (2002). Response to contrasting verb retrieval treatments: A case study. Aphasiology, 16, 1031-1045.

Raymer, A., Singletary, F., Rodriguez, A., Ciampitti, M., Heilman, K., & Gonzalez Rothi, L. (2006). Effects of gesture+verbal treatment for noun and verb retrieval in aphasia. Journal of the International Neuropshcological Society, 12(6), 867-882.

Rose, M. (2006). The utility of arm and hand gestures in the treatment of aphasia. Advances in Speech Language Pathology, 8 (2), 92-109.

Schneider, S., & Thompson, C. (2003). Verb production in agrammatic aphasia: The influence of semantic class and argument structure properties on generalization. Aphasiology, 17 (3), 213-241.

Thompson, C.K. (2001). Treatment of underlying forms: a linguistic specific approach for sentence production deficits in agrammatic aphasia. In R. Chapey (Ed.) Language Intervention Strategies in Aphasia and Related Neurogenic Communication Disorders, New York, Lippincott Williams & Wilkins.

Wambaugh, J., Doyle, P., Martinez, A., & Kalinyak-Fliszar, M. (2002). Effects of two lexical retrieval cueing treatments on action naming in aphasia. Journal of Rehabilitation Research and Development, 39(4), 455-466.

Wambaugh, J., Linebaugh, C., Doyle, P., Martinez, A., Kalinyak-Fliszar, M., & Spencer, K. (2001). Effects of two cueing treatments on lexical retrieval in aphasic speakers with different levels of deficit. Aphasiology, 15(10/11), 933-950.

Webster, J., Morris, J., & Franklin, S. (2005). Effects of therapy targeted at verb retrieval and the realisation of the predicate argument structure. Aphasiology, 19, (8), 748-764

Table 1: Participant characteristics

	KC	MW	PF	GF	MT
Age	45	55	57	63	53
Months post onset	82	60	21	21	38
Apraxia of Speech	mild	mild	mild	Moderate-severe	mild
Limb apraxia: TOLA	moderate	moderate	mild	moderate	moderate
WAB AQ	67.6	64.7	75.8	39	61.1
Aphasia type	Broca's	Broca's	Broca's	Broca's	Broca's
Predominant verb impairment type	Word forms	Word forms	Word form	Word form	Word meanings
VAST: Action naming	21/40	4/40	33/40	1/40	4/40
VAST: Verb comprehension	37/40	34/40	38/40	36/40	10/40

Table 2 Effect sizes for each condition (Busk & Serlin (1992) d)

	KC	MW	PF	GF	MT
Gesture and semantic	4.2	5.93	6.25	6.79	1.03
Semantic	8.2	5.85	8.58	4.96	0.06
Gesture	8.07	***	4.24	***	***
Repetition	***	3.43	11.54	0.58	1.18
Control 1	1.5	0.77	1.67	1.69	-.049
Control 2	1.75	1.02	***	***	-0.85

*** Conditions varied with participants

Table 3 Pre-post scores on selected tests

	KC		MW		PF		GF	
	Pre	Post	Pre	Post	Pre	Post	Pre	P
VAST Action Naming (out of 40)	21	30(8nt)*	4	15(2nt)*	21	33*	1	1
VAST Sentence Construction (out of 20)	0	0	2	5	Na	na	15	1
Picture Description- total verbs	4	15(4nt)	27	35	8	15	0	
Conversation- total verbs	10	21(7nt)	24	28	172	189	44	
LCQ: Self	58	62	66	58 *	87	86	98	
: Close Other	58	50*	65	56 *	102	na	97	

*Significant difference McNemar's Test ($p<.01$);
(Xnt)= number of items improved that were not direct treatment targets
LCQ: La Trobe Communication Questionnaire, lower score = better perception of communicative ability

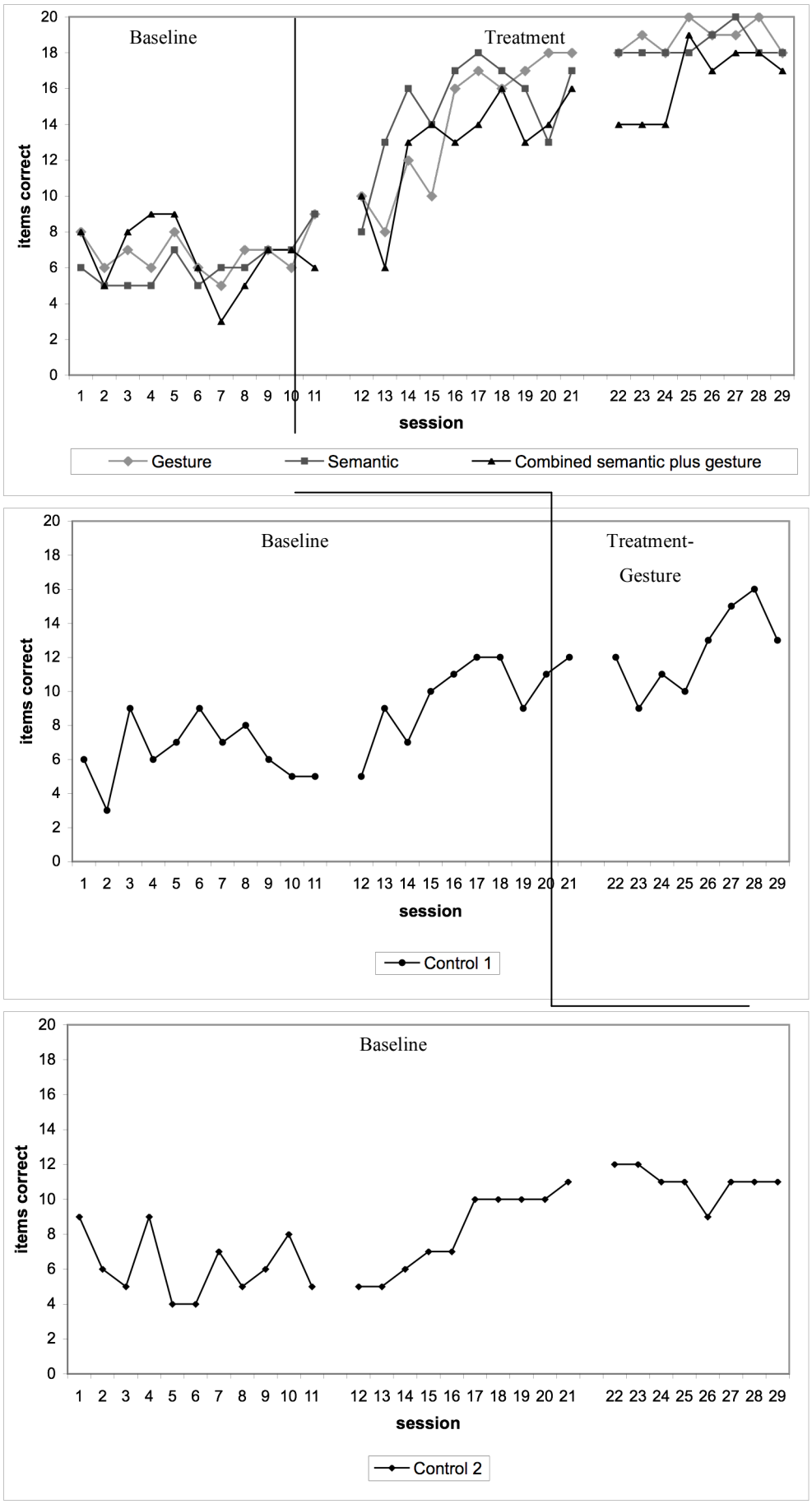

Figure 1. Comparative treatment results for KC

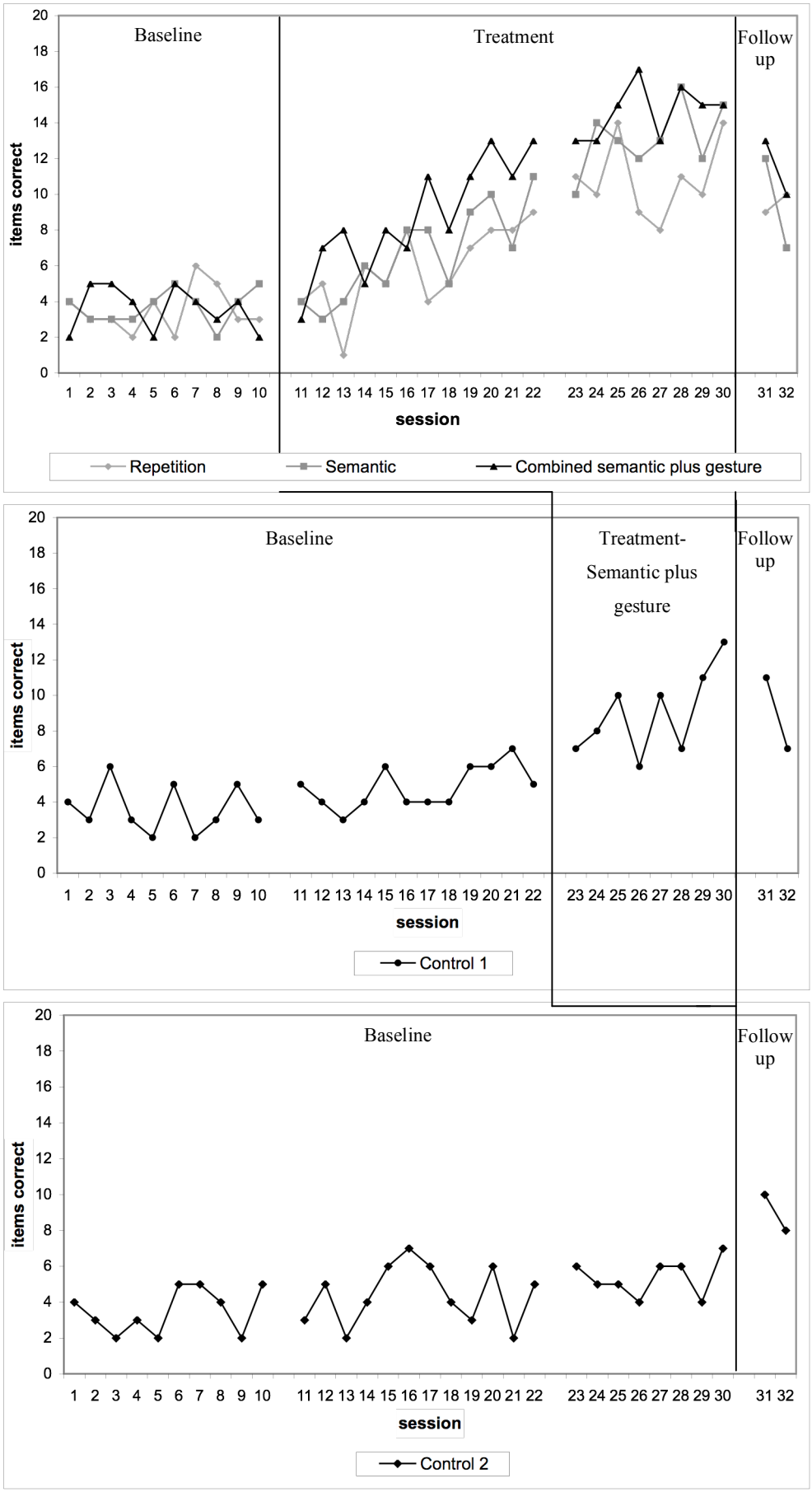

Figure 2. Comparative treatment results for MW

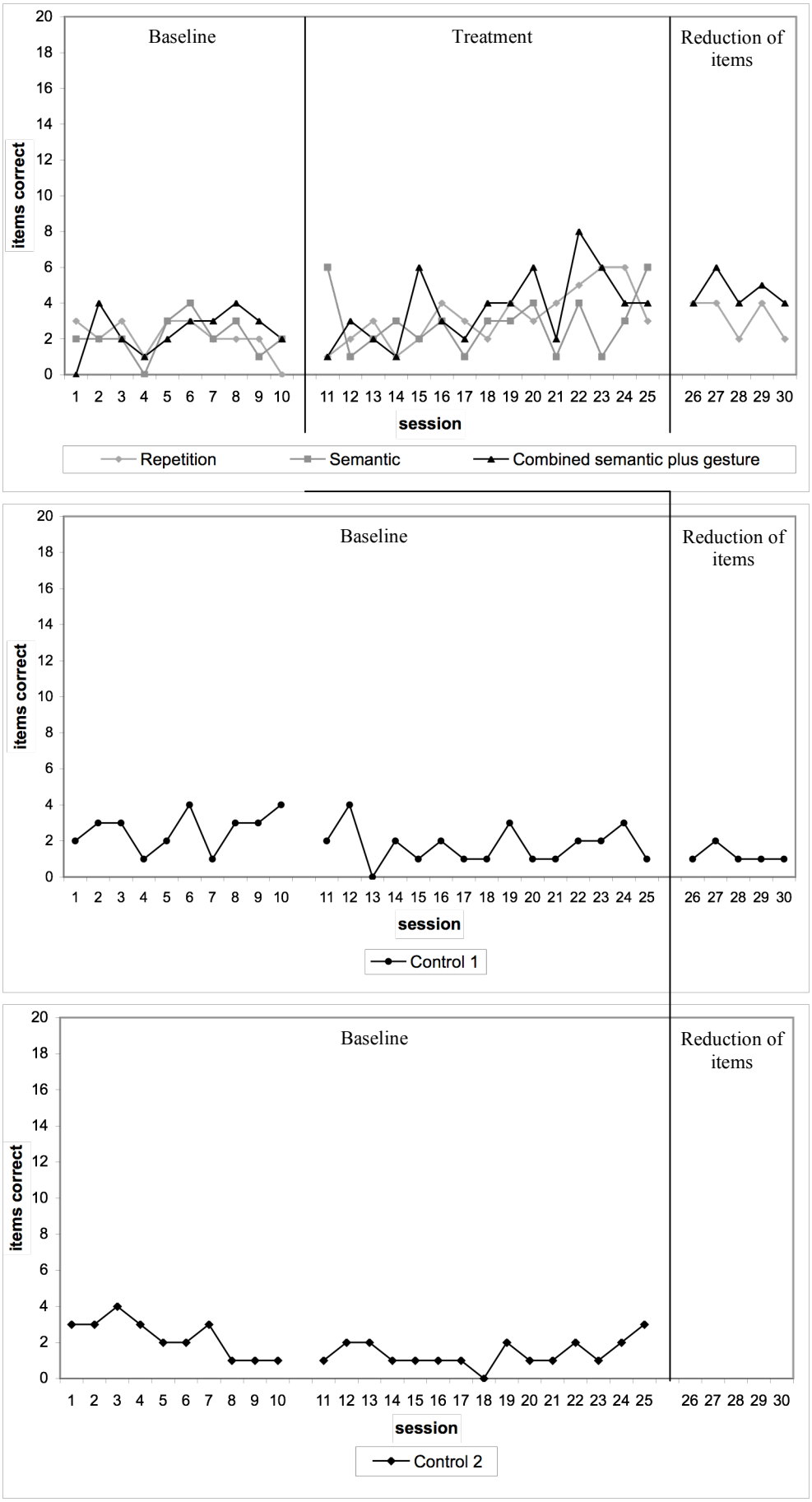

Figure 3. Comparative treatment results for MT

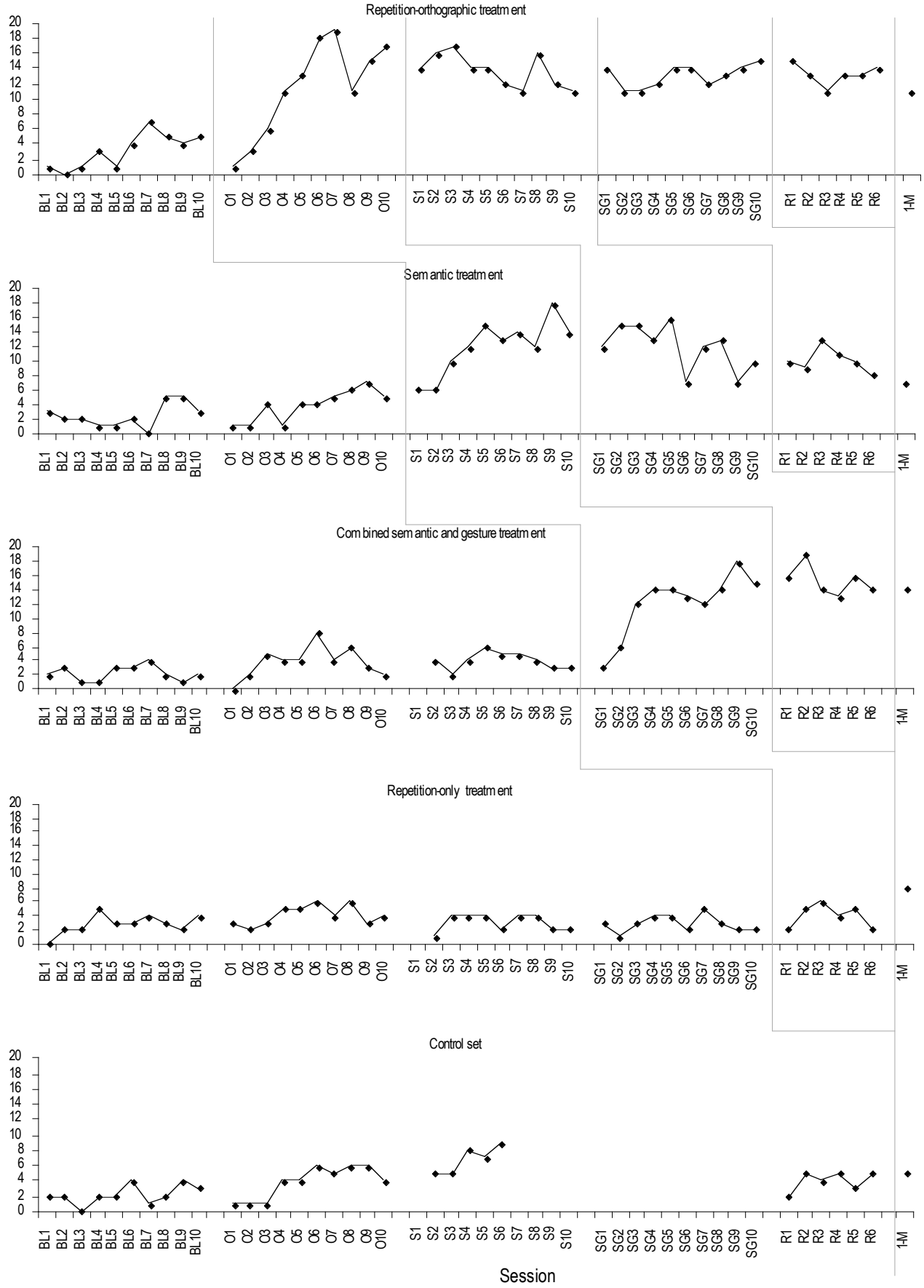

Figure 4. Comparative treatment results for GF

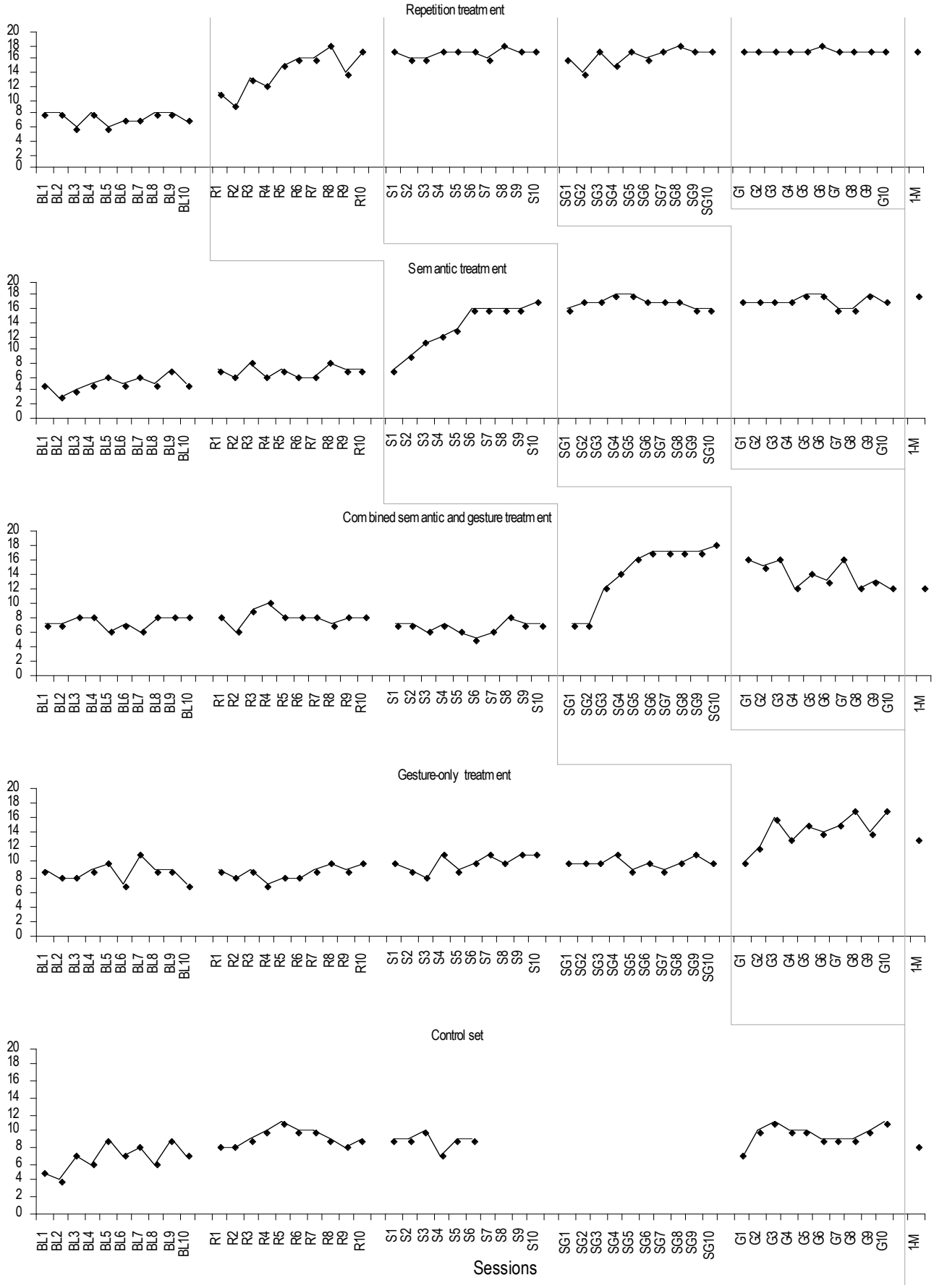

Figure 5. Comparative treatment results for PF