Background

People with nonfluent aphasia have been reported to demonstrate relative verb to noun deficits. Verb production in agrammatic speech has also been reported to be completely omitted or relatively sparse when compared to nouns, with little diversity and semantic specificity when produced (Saffran, Berndt, & Schwartz, 1989). Unlike nouns, each verb appears to possess an underlying set of syntactic and semantic properties that influences the ease of its retrieval from the mental lexicon, such as argument structure complexity (Kim & Thompson, 2000). Therefore, it is necessary for researchers undertaking treatment studies for verb retrieval to take these variables into consideration when selecting treatment stimuli. In addition, verbs are proposed to be the central element that dictates grammatical sentence production. Treatment studies that have targeted isolated verb retrieval in people with agrammatic Broca's aphasia have reported a corresponding improvement in sentence production, despite no generalization to untrained stimuli (Marshall, Pring, & Chiat, 1998; Schneider & Thompson, 2003) and despite no direct training of sentence production (Raymer & Ellsworth, 2002; Rose & Sussmilch, 2008). However, evidence of single verb therapy leading to improved grammatical sentence production is limited.

Verb deficits may arise from impairment at the different stages of word production. Treatment studies have examined the use of impairment-level treatments, such as semantic or phonologic treatments, to target these impaired linguistic processes (Nickels, 2000). In addition to specific linguistic-level treatments, recent intervention studies have examined the use of arm and hand gesture during word retrieval training. Several authors have suggested a close link between gestures and verb production (Bak & Hodges, 1997; Druks, 2002). Gesture facilitation using iconic gestures has been found to be effective in improving verb retrieval accuracy in individuals with nonfluent aphasia (Hoodin & Thompson, 1983; Pashek, 1998). To date, treatments investigating the effects of gestures for remediating verb retrieval deficits have been scarce and the utility of the studies is limited by the lack of control for psycholinguistic variables. However, the positive treatment effects reported in the small number of gesture studies warrant further investigation. Few aphasia treatment studies have examined single-verb treatment generalization effects to other linguistic measures in different contexts. Those studies that have investigated generalization effects in discourse tasks are generally yet to identify significant generalization to more natural communicative contexts. Determining the discourse-level effects of verb retrieval training is important for informing researchers and clinicians about the ecological value of single verb retrieval treatments.

Method

For this study, we employed a single-participant, multiple-baseline-across-conditions design replicated across two individuals. One female participant, GF, and one male participant, PF, were recruited. Pre-treatment, the type and severity of each participant's speech, language, and selected cognitive functions were established by the pattern of test results obtained from a range of standardized assessments (see Tables 1 & 2). Discourse samples from story retell and a 20-minute conversation were also obtained to investigate generalization effects. GF presented with severe Broca's

aphasia and significant apraxia of speech, with verb production deficits hypothesized to arise from impairments at multiple levels of word production. PF demonstrated moderate Broca's aphasia, mild apraxia of speech, and primarily a phonologically-based verb retrieval impairment.

Following assessments, participants underwent ten baseline sessions where they attempted to name 100 black-and-white action line drawings. In all baseline sessions, no cues or feedback were given. Participants were asked to "use one action word to describe what is happening in the picture".

Treatment was conducted in four distinct, sequential phases using four different treatment conditions. Each treatment condition lasted for ten sessions, sessions occurring at a rate of two or three sessions per week. For participant PF, the treatment phases were as follow: phase one – repetition-only; phase two – semantic; phase three – combined semantic and gesture; and phase four – gesture-only. Treatment protocols for GF were similar to PF's, with the exception of the additional provision of written word forms. Hence for GF, the treatment phases were as follows: phase one – repetition-orthographic; phase two – semantic; phase three – combined semantic and gesture; phase four – repetition-only. The substitution of the repetition-only condition for the gesture-only treatment condition, aimed to delineate the effects of reading, hearing, and repeating the words (as in repetition-orthographic treatment) from that of just hearing and repeating the words (repetition-only treatment).

When all four treatments were completed, both participants were reassessed on the same tasks tested pre-treatment. Maintenance of therapy effects was examined 1 month and 3 months post treatment.

Results

Both participants differed in their responses to treatments (see Figures 1 & 2). When naming accuracy was examined immediately post-treatment, GF demonstrated significantly improved naming performance following repetition-orthographic, semantic, and combined semantic and gesture conditions; while PF's naming accuracy improved significantly above baseline levels for items trained in repetition-only, semantic and combined semantic and gesture conditions. When GF's naming accuracy was reassessed at 3-months, naming accuracy was not maintained significantly above baseline levels for all treatment conditions. PF's naming accuracy for items trained in the repetition-only and semantic treatment conditions continued to be significantly maintained above baseline levels at 3-months.

Similar to most word-remediation aphasia studies, both GF and PF did not demonstrate improved naming accuracy for untreated verbs. Immediately post-treatment, both participants demonstrated an overall increase in the proportion of verbs produced post-treatment on three discourse tasks (picture description, story retell, and a 20-minute conversation). PF also exhibited significantly improved production of grammatical sentences in the picture description task, but not in story retell or during conversation. GF remained severely impaired in her sentence production ability post-treatment. However, despite limited change in lexical, syntactical and morphological linguistic production post-treatment during conversation, both participants exhibited increased informativeness in their verbal output. Both participants also demonstrated an unstable increase in the naming accuracy for exposed but untreated control items.

Discussion

Results indicated that treatments differed for each participant. This difference in treatment responses may be attributed to various factors, including treatment strategies, stimuli characteristics (e.g., length of time items were exposed to uncorrected errorful naming attempts; semantic relatedness to other stimuli, etc.), and/or participant's underlying cognitive and language impairments. Further research involving a larger number of participants with a range of neuropsychological profiles may advance our current understanding of the factors that predict therapy outcome measures in different individuals.

The difference in GF's naming performance immediately post-treatment, at 1-month and at 3-month follow-up highlights the importance of assessing treatment effects at different intervals before meaningful treatment effects can be established.

The demonstrated increase in naming accuracy for untreated items found here has been reported by a number of researchers. Researchers should consider incorporating a set of untrained probe stimuli to which participants are exposed to only during baseline and follow-up phases for better justification of treatment effects. Moreover, this study also demonstrated that repeated attempts at naming without feedback or corrections for incorrect production might render stimulus items to become resistant to treatment. Thus, future studies should consider limiting exposure to items left untreated.

The study also identified discrepant performance between confrontation naming and naming during discourse, as well as between different discourse genres, further maintaining the clinical and ecological significance of incorporating different discourse tasks when establishing treatment efficacies.

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Table 1

Participant GF assessment results

Measure	Pre-treatment score	Post-treatment score
Western Aphasia Battery-Revised (Kertesz, 2007)		
Aphasia Quotient (AQ)	39	41.6
Language Quotient (LQ)	47.6	57.3
Cortical Quotient (CQ)	51.5	57.7
Aphasia Classification	Broca's	Broca's
Subtests		
Spontaneous speech	5 / 20	5 / 20
Auditory verbal comprehension	8 / 10	8.45 / 10
Repetition	3.5 / 10	3.2 / 10
Naming and word finding	3 / 10	4.1 / 10
Reading	9.8 / 20	15.4 / 20
Writing	10.3 / 20	12.7 / 20
Apraxia	7.7 / 10	8.33 / 10
Constructional, visuospatial, and calculation	6.3 / 10	6.1 / 10
Raven's Colored Progressive Matrices	17 / 37	16 / 37
Test of Oral and Limb Apraxia (Helm-Estabrooks, 1992)		
Limb apraxia total	87 / 120	100 / 120
Proximal total	49 / 60	50 / 60
Distal total	38 / 60	50 / 60
Oral apraxia total	56 / 60	56 / 60
Nonrespiratory	30 / 30	30 / 30
Respiratory	26 / 30	26 / 30
Gestured pictures total	23 / 45	25 / 45
Proximal	10 / 15	12 / 15
Distal	10 / 15	8 / 15
Oral	3 / 15	5 / 15
Verb and Sentence Test (Bastiaanse et al., 2002)		
Comprehension (120 possible)		
Verb comprehension	36 / 40	37 / 40
Sentence comprehension	18 / 40	19 / 40
Grammaticality judgement	34 / 40	31 / 40
Production (140 possible)		
Action naming	1 / 40	11 / 40*
Filling in finite verbs in sentences	Terminated	Terminated
Filling in infinitives in sentences	Did not administer	Did not administer
Sentence construction	Terminated	Terminated
Sentence anagrams with pictures	12 / 20	10 / 20
Sentence anagrams without pictures	Terminated	9 / 20
Wh-anagrams	Terminated	Terminated
Object and Action Naming Battery (Druks and Materson, 2000)		
Action naming (100 possible)	12 / 100	N.A.
Pyramids and Palm Trees (Howard & Patterson, 1992)		
3 pictures version	46 / 52 (88.46%)	48 / 52 (92.3%)
La Trobe Communication Questionnaire		
Self	98	78*
Others	97	97

*denotes change was statistically significant

Table 2

Participant PF assessment results

Measure	Pre-treatment score	Post-treatment score
Western Aphasia Battery-Revised (Kertesz, 2007)		
Aphasia Quotient (AQ)	75.8	82*
Language Quotient (LQ)	82.5	89.2
Cortical Quotient (CQ)	84.2	88.6
Clinical diagnosis	Broca's	Broca's
Subtests		
Spontaneous speech	13 / 20	15 / 20
Auditory verbal comprehension	9.8 / 10	10 / 10
Repetition	8.8 / 10	9.4 / 10
Naming and word finding	6.3 / 10	7.1 / 10
Reading	17.2 / 20	18.4 / 20
Writing	17.6 / 20	19.3 / 20
Apraxia	9.3 / 10	9.2 / 10
Constructional, visuospatial, and calculation	9.5 / 10	9 / 10
Raven's Colored Progressive Matrices	34 / 37	34 / 37
Test of Oral and Limb Apraxia (Helm-Estabrooks, 1992)		
Limb apraxia total	104 / 120	110 / 120
Proximal total	53 / 60	57 / 60
Distal total	51 / 60	53 / 60
Oral apraxia total	51 / 60	58 / 60
Nonrespiratory	28 / 30	30 / 30
Respiratory	23 / 30	28 / 30
Gestured pictures total	26 / 45	29 / 45
Proximal	14 / 15	12 / 15
Distal	8 / 15	8 / 15
Oral	4 / 15	9 / 15
Verb and Sentence Test (Bastiaanse et al., 2002)		
Comprehension (120 possible)		
Verb comprehension	38 / 40	37 / 40
Sentence comprehension	36 / 40	39 / 40
Grammaticality judgment	37 / 40	39 / 40
Production (140 possible)		
Action naming	21 / 40	33 / 40**
Filling in finite verbs in sentences	8 / 10	8 / 10
Filling in infinitives in sentences	8 / 10	8 / 10
Sentence construction	15 / 20	19 / 20
Sentence anagrams with pictures	20 / 20	20 / 20
Sentence anagrams without pictures	20 / 20	20 / 20
Wh-anagrams	20 / 20	20 / 20
Object and Action Naming Battery (Druks and Materson, 2000)		
Action naming (100 possible)	79 / 100	N.A.
Pyramids and Palm Trees (Howard & Patterson, 1992)		
3 pictures version	48 / 52 (92.3%)	48 / 52 (92.3%)
La Trobe Communication Questionnaire		
Self	87	86
Others	102	N.A.

* denotes change was clinically significant
** denotes change was statistically significant
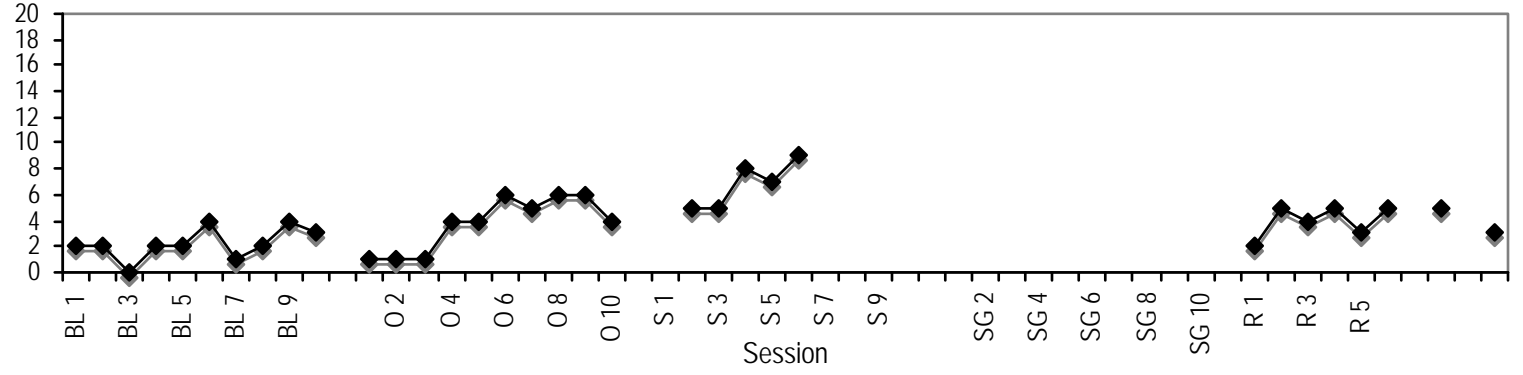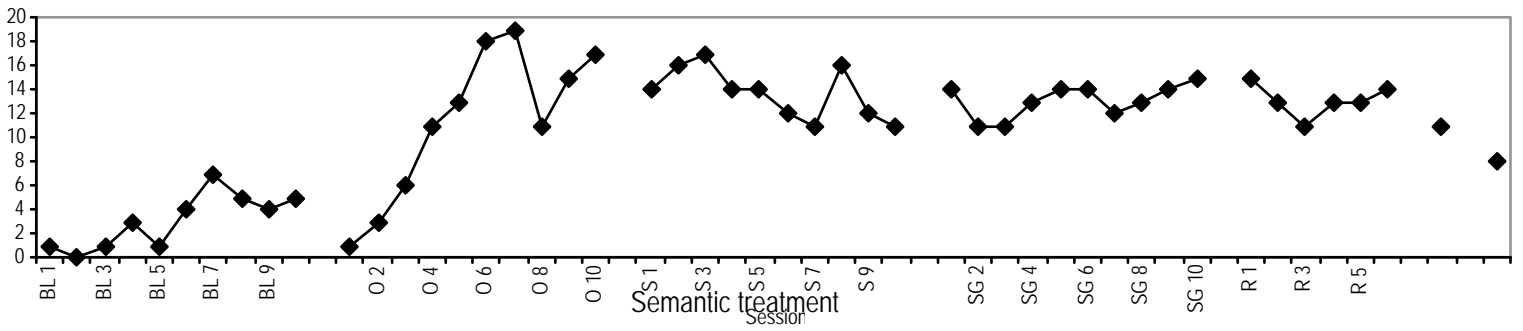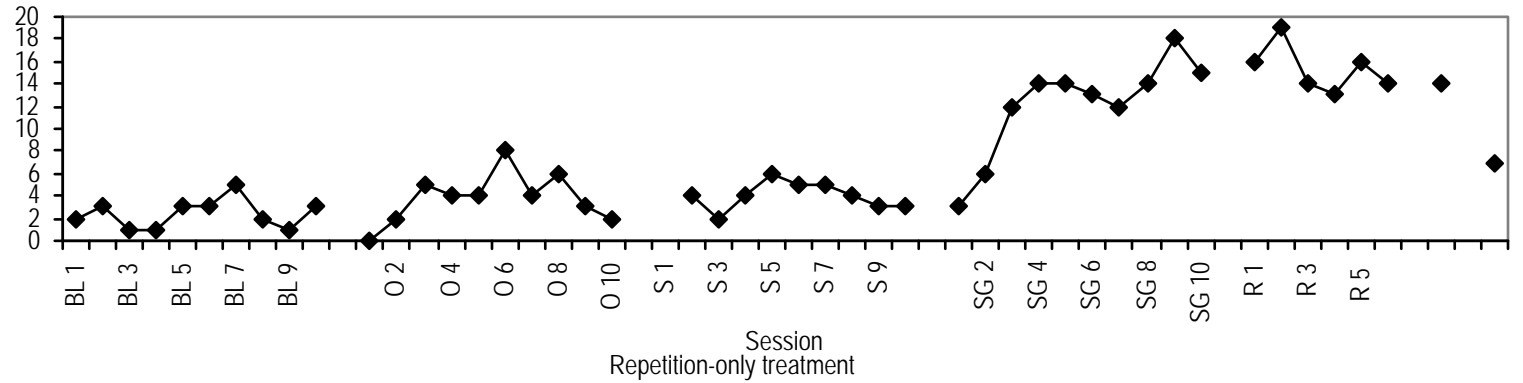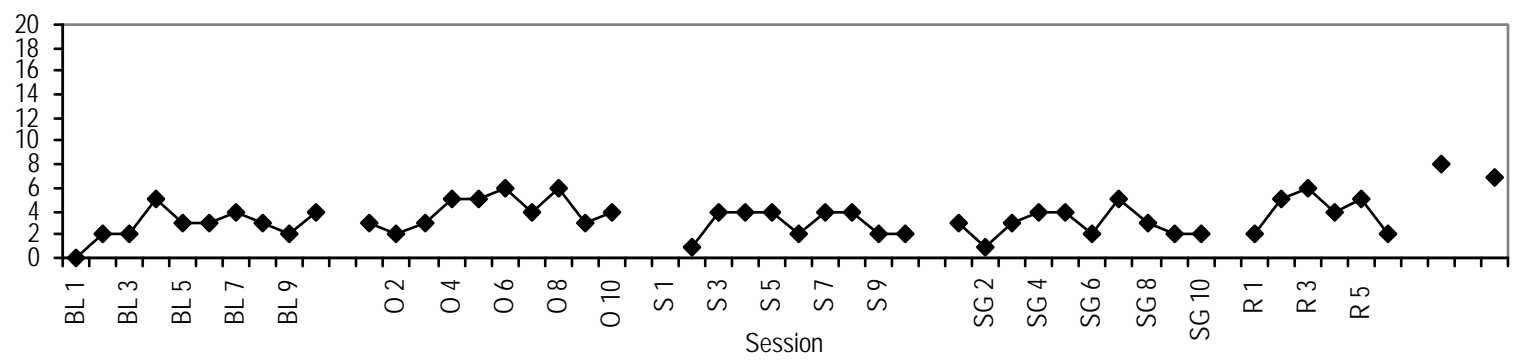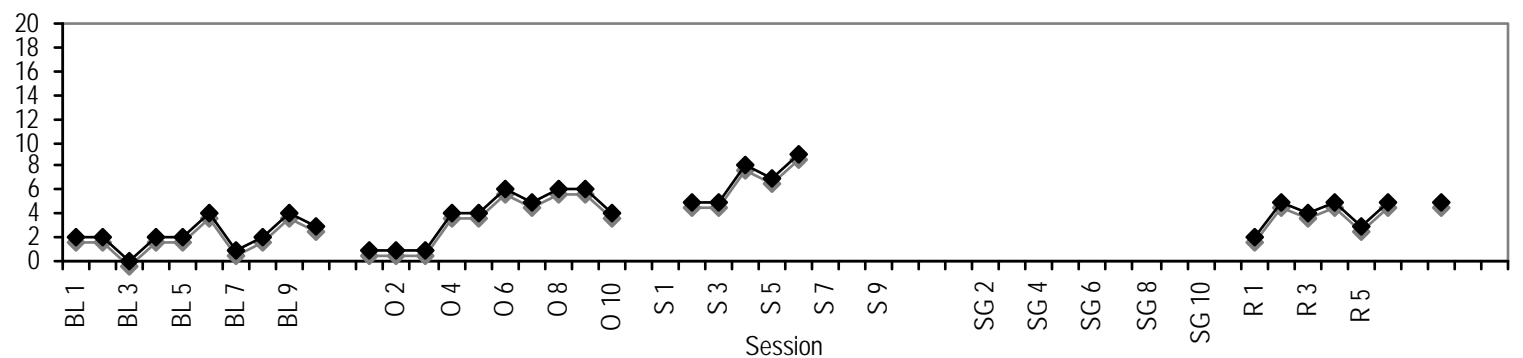
Figure 1. Probe results for GF
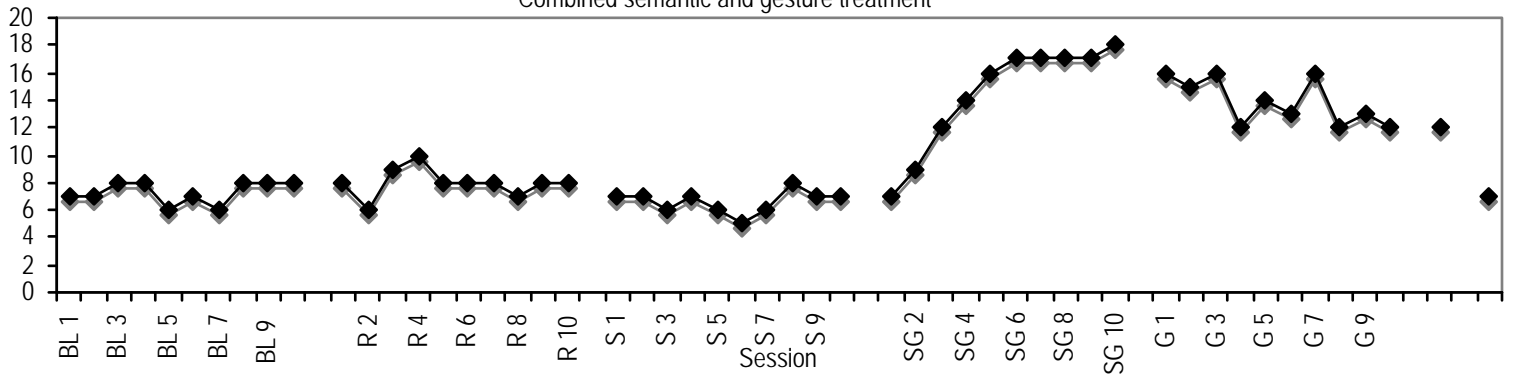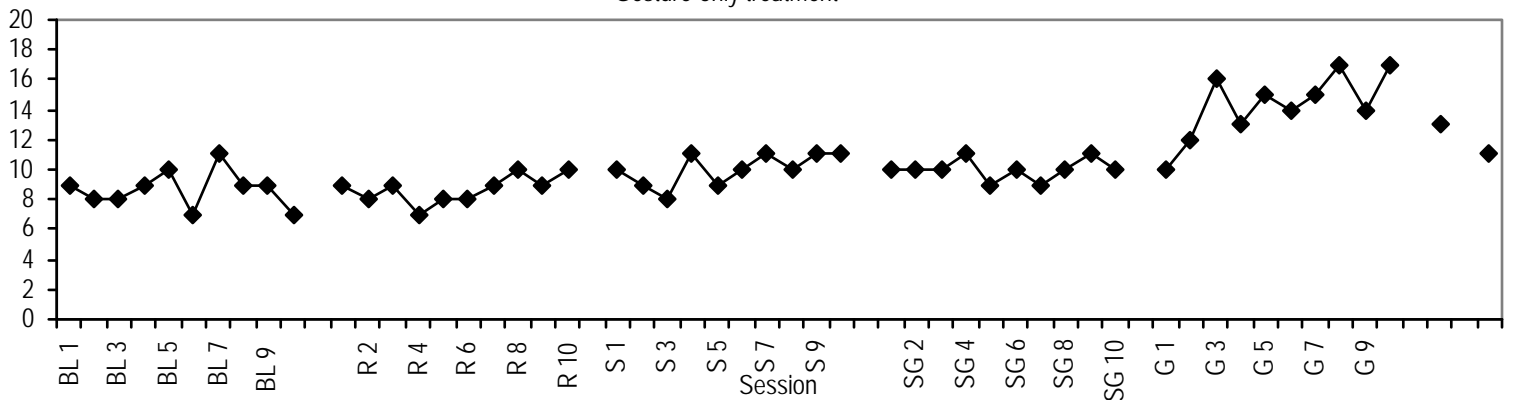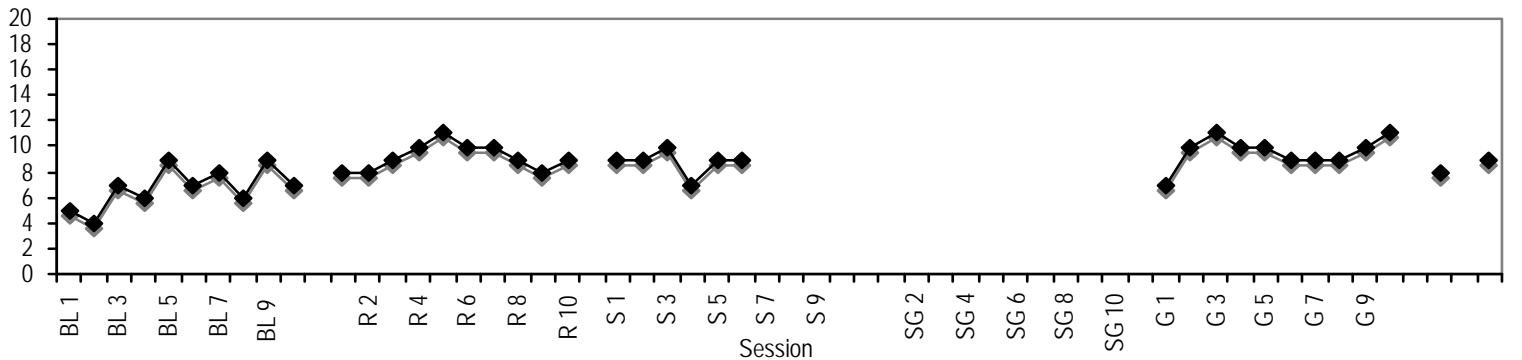
Figure 2. Probe results for PF