Treating naming impairments in aphasia: Findings from a phonological components analysis treatment

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Background: A new phonologically based treatment that we developed for addressing naming deficits in aphasia—the phonological components analysis (PCA) treatment—is presented. The PCA was modelled after the semantic feature analysis (SFA) approach (Boyle & Coelho, 1995). The SFA approach was chosen as a model for two reasons. First, results from the semantic therapies that have used SFA have been encouraging (e.g., Boyle, 2004; Boyle & Coelho, 1995; Coelho, McHugh, & Boyle, 2000; Conley & Coelho, 2003; Lowell, Beeson, & Holland, 1995). Second, SFA incorporates the principle of choice, a factor that has been identified by some as being important in producing longer-lasting effects of treatment (e.g., Hickin, Best, Herbert, Howard, & Osborne, 2002). The PCA was developed to serve as a comparable phonological comparison for the SFA approach with the future goal of comparing the relative effects of both types of therapies.

Aims: The primary aim of this investigation was to document the effectiveness of PCA treatment for the remediation of naming deficits in aphasia. In addition, we wished to examine potential maintenance and generalisation effects associated with this treatment.

Methods & Procedures: The PCA treatment followed the protocol of Coelho et al. (2000). The target picture was presented in the centre of a chart and the participant was asked to name it. Irrespective of his/her ability to name the picture, the participant was asked to identify five phonological components related to the target item (i.e., rhymes...
Anomia, a difficulty in retrieving words for production, is found in virtually all persons with aphasia, regardless of the constellation of their other language symptoms (Goodglass & Wingfield, 1997). In the past few decades there have been many treatment studies directed at remediating word production deficits. These treatments have generally been of two broad types: semantic, or meaning-based treatments, and phonological, or word-form based treatments.

In her extensive review of therapy for naming disorders, Nickels (2002) identifies semantic feature analysis (SFA) as a treatment technique that both she and its authors (Boyle, 2004; Boyle & Coelho, 1995; Coelho et al., 2000; Conley & Coelho, 2003) claim is an approach designed to remediate semantically based naming impairments. Originally developed for individuals with traumatic brain injury (see Haarbauer-Krupa, Moser, Smith, Sullivan, & Szekeres, 1985; Massaro & Tompkins, 1992), it has been used successfully in the treatment of anomia for individuals with aphasia subsequent to stroke (Boyle, 2004; Boyle & Coelho, 1995; Conley & Coelho, 2003; Lowell et al., 1995) and traumatic brain injury (Coelho et al., 2000). In this technique a picture for naming is placed in the centre of a chart (i.e., a whiteboard). Regardless of whether the individual with anomia can name the item, the clinician then elicits the semantic features of the target item from the individual, according to six specified categories, such as the superordinate category (i.e., the group that the item belongs to), its physical properties, its use, etc. The features provided by the individual with or without the aid of the clinician are then written on the board and reviewed before the individual attempts to produce the name. If the individual is unable to name the picture after feature presentation, the clinician provides the name and the individual repeats it (Boyle, 2004).

The basis for the SFA approach lies in the theory of spreading activation (Collins & Loftus, 1975), in which it is thought that the provision of features for a target activates the semantic network for that target, which in turn makes it more likely that the item itself will be activated beyond a minimum threshold level required for correct word production. According to Boyle (2004), this view is also consistent with contemporary theories of word production, such as discrete-stage (e.g., Levelt, Roelofs, & Meyer, 1999) or interactive activation models (Foygel & Dell, 2000) of lexical access. Some advocates of the approach claim that the facilitative effects of SFA, in which it is believed that the activation threshold for a target word is reached, translate into improvements in therapy because patients learn to employ a strategy...
An interesting aspect of SFA is that feature generation provides the individual with anomia with the opportunity to generate his or her own responses or, if unable to do so, to choose the feature that he/she feels best represents the feature in question. Hickin et al. (2002) identify the importance of choice to improvement in treatment, claiming that it stimulates deeper processing of the therapy task and results in longer-lasting improvements in word retrieval.

Relative to the notion of choice, Hickin et al. (2002) also point out that a difference between semantic and phonological treatment techniques lies in the provision of choice in the treatment task: an element of choice is more likely to be found in semantic tasks, such as SFA, or other semantically based treatments (e.g., word-to-picture matching used in Marshall, Pound, White-Thomson, & Pring, 1990) than in phonologically based treatment tasks where the stimuli or cues are usually provided such as with first letter cueing, providing rhyming words, and word repetition (e.g., Best, Herbert, Hickin, Osborne, & Howard, 2002; Miceli, Amitrano, Capasso, & Caramazza, 1996; Raymer, Thompson, Jacobs, & LeGrand, 1993; Wambaugh, 2003; Wambaugh, Cameron, Kalyanyak-Fliszar, Nessler, & Wright, 2004; cf. Robson, Marshall, Pring, & Chiat, 1998). In their study, Hickin et al. (2002) provided a choice of phonological or orthographic cues as part of the therapy.

In the past, the effects of semantic treatment were thought to be more effective and/or longer-lasting than phonological treatments (Horton & Byng, 2000; Howard, Patterson, Franklin, Orchard-Lisle, & Morton, 1985; Nickels, 2002); however many treatment studies, such as those mentioned above, have now shown phonological treatments to be effective. In fact, Howard (2000) has gone so far as to suggest that the distinction between semantic and phonological tasks may be misleading, as both types of task usually incorporate at least some component of the other processing level (e.g., most semantically based tasks require the patient to produce the word and many phonologically based tasks use picture stimuli). To this end, he has argued that, in principle, both types of task should equally facilitate word retrieval in individuals with aphasia and he found support for this notion in his reanalysis of the data in Howard et al. (1985). Wambaugh and colleagues (Wambaugh, 2003; Wambaugh et al., 2001) also found facilitatory effects for both semantic and phonological treatments when comparing the relative effects of the two in the same individuals. Similarly Martin and colleagues, using their contextual repetition priming technique (involving presentation and repetition of a set of words related either semantically, phonologically, or unrelated), have found evidence to suggest that for individuals for whom semantic processing is spared, both semantic and phonological conditions promote improved naming (Martin, Fink, & Laine, 2004; Martin, Fink, Renvall, & Laine, 2006; Renvall, Laine, Laakso, & Martin, 2003).

With modification, this approach has also been found to be beneficial for a patient with a lexical semantic deficit, although no effects of treatment generalisation were found (Renvall, Laine, & Martin, 2007).

While comparisons between the effectiveness of semantically and phonologically based therapies for anomia are important in uncovering which type of therapy may be best for which type of patient, not many studies have directly compared the effects of the two methods with the same individuals (Nickels, 2002). Moreover of those that have, with the exception of only a few studies (e.g., Martin et al., 2004, 2006a, Renvall et al., 2003; Wambaugh et al., 2001), semantic and phonological treatments have not
been well matched in terms of such factors as structure of the therapy task and response demands (e.g., self generation of target, choice of target, cued response). As a result, it is difficult to compare the relative effects of each treatment type in a given study. In addition, in both the semantic cueing and phonological cueing treatment protocols used in Wambaugh et al. (2001), and in the contextual repetition priming treatments of Martin and colleagues (Martin et al., 2004, 2006; Renvall et al., 2003) there was no element of choice for the patient to engage in. As already noted, this has been suggested as being an important element in promoting treatment effectiveness (Byng & Jones, 1993; Hickin et al., 2002; Robertson & Murre, 1999).

The purpose of the present investigation was to examine the effectiveness of a phonological components analysis (PCA) treatment we developed for the remediation of naming deficits in aphasia that was modelled after the semantic feature analysis (SFA) approach. SFA was chosen as a model for two reasons. First, as already reviewed above, results from the semantic therapies that have used SFA have been encouraging (e.g., Boyle, 2004; Boyle & Coelho, 1995; Coelho et al., 2000; Conley & Coelho, 2003; Lowell et al., 1995). Second, SFA incorporates the principle of choice, a factor that has been identified by some as being important in producing longer-lasting effects of treatment (e.g., Hickin et al., 2002). The PCA was developed to serve as a comparable phonological comparison for the SFA approach with the future goal of comparing the relative effects of both types of therapies. As findings to date have been equivocal regarding whether treatment effects are greatest when therapy is impairment specific (e.g., Greenwald, Raymer, Richardson, & Rothi, 1995; Hillis & Caramazza, 1994; Wambaugh, 2003; Wambaugh et al., 2001, 2004), we have chosen to administer our PCA treatment to patients with anomia regardless of impairment type, with a secondary aim being to track the patient factors that might contribute to the success of PCA treatment.

METHOD

Participants

A total of 10 individuals with aphasia participated in this investigation: 6 men and 4 women (mean age: 61.7 years; mean level of education: 13.9 years) (see Table 1). The participants were recruited from aphasia centres in the Toronto and Ottawa areas. All participants provided written informed consent to participate in this investigation. All participants were right-handed, English-speaking individuals who had experienced a single left-hemisphere cerebrovascular accident and were at least 1 year post-onset at the time of enrolment. Classification of aphasia, based on the results of the Boston Diagnostic Aphasia Examination (Goodglass, Kaplan, & Barresi, 2001), administered by trained research assistants during screening, revealed that six individuals presented with Broca’s aphasia, two with anomic aphasia, one with mixed nonfluent aphasia, and one with Wernicke’s aphasia. All participants had a naming impairment defined by less than 75% accuracy on the Boston Naming Test (BNT) (Goodglass et al., 2001). All participants had visual perceptual abilities within normal limits as determined by the Minimal Feature Matching subtest of the Birmingham Object Recognition Battery (Riddoch & Humphreys, 1993). Hearing for 8 of the 10 participants was screened and found to be within normal limits.1 All

1 Due to an administration error, hearing was not screened for two of the participants.
participants were administered a motor speech exam to rule out the presence of apraxia of speech, the results of which were reviewed by two speech-language pathologists. None of the participants was receiving formal speech-language therapy at the time of testing. Other exclusion criteria included a known history of drug or alcohol abuse, a history of major psychiatric illness and/or other neurological illness.

Patients’ naming impairments may be due to impaired access to semantic, lexical, and/or phonological representations (see Martin et al., 2006; Schwartz, Dell, Martin, Gahl, & Sobel, 2006). In an effort to determine the loci of impairment in the participants in this study, additional pre-therapy tests were administered (see Table 2). To assess the integrity of semantic representations, the picture version of the *Pyramids and Palm Trees Test* (Howard & Patterson, 1992) was administered. As can be seen in the table, all but one patient (P2) scored below the cut-off for normal performance on this test. However, it is generally considered that individuals who score 90% or better do not have a clinically significant impairment on this task (Howard & Patterson, 1992). Based on this criterion, five participants can be considered to have intact semantic representations (P1, P2, P3, P7, P8), whereas five appear to have at least some degree of impairment in conceptual semantics (P4, P5, P6, P9, P10). To assess the status of lexical semantic knowledge, the Spoken Word–Picture Matching subtest of the *PALPA* (Kay, Lesser, & Coltheart, 1992) was administered. As can be seen in the table, performance for all but one participant (P10) was within the range of normal for Spoken Word–Picture Matching. Performance on the Written Word–Picture Matching subtest of the *PALPA* showed that five patients scored below the cut-off for normal performance on this test (P2, P5, P6, P7, P10). To investigate whether there was a dissociation between conceptual versus lexical-semantic processing, patients were administered the spoken word to written word matching subtest of the *PALPA*. There are two versions of this test. In the first, the participant has to identify a written word from a set of three semantic distractors. In the second there are no semantic distractors. Three

### Table 1

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age (years)</th>
<th>Education (years)</th>
<th>Post Stroke (years)</th>
<th>Sex</th>
<th>Etiology</th>
<th>Aphasia Type</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>71</td>
<td>13</td>
<td>12</td>
<td>M</td>
<td>Left Ischaemic CVA</td>
<td>Broca’s</td>
</tr>
<tr>
<td>2</td>
<td>57</td>
<td>8</td>
<td>3</td>
<td>M</td>
<td>Left CVA</td>
<td>Broca’s</td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>21</td>
<td>1</td>
<td>F</td>
<td>Left CVA</td>
<td>Broca’s</td>
</tr>
<tr>
<td>4</td>
<td>65</td>
<td>14</td>
<td>14</td>
<td>F</td>
<td>Left CVA</td>
<td>Anomia</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
<td>16</td>
<td>3.5</td>
<td>F</td>
<td>Left MCA</td>
<td>Broca’s</td>
</tr>
<tr>
<td>6</td>
<td>73</td>
<td>12</td>
<td>4</td>
<td>M</td>
<td>Left MCA</td>
<td>Mixed Nonfluent</td>
</tr>
<tr>
<td>7</td>
<td>57</td>
<td>6</td>
<td>17</td>
<td>M</td>
<td>Left CVA cerebral hemorrhage</td>
<td>Broca’s</td>
</tr>
<tr>
<td>8</td>
<td>52</td>
<td>18</td>
<td>6.5</td>
<td>M</td>
<td>Left CVA</td>
<td>Broca’s</td>
</tr>
<tr>
<td>9</td>
<td>72</td>
<td>12</td>
<td>1.5</td>
<td>F</td>
<td>Left temporal parietal cerebral hemorrhage</td>
<td>Wernicke’s</td>
</tr>
<tr>
<td>10</td>
<td>70</td>
<td>19</td>
<td>2.5</td>
<td>M</td>
<td>Left CVA</td>
<td>Anomia</td>
</tr>
</tbody>
</table>

**Mean** 61.7 13.9 6.5

*According to CT scan and/or neurological reports*

*B Based on Boston Diagnostic Aphasia Examination (BDAE) (Goodglass et al., 2001)
participants in particular (P3, P7, P10) appear to demonstrate poorer performance on the version of the task with semantic distractors, suggesting difficulties in lexical semantics. Based on the results of the tasks above, it would appear that most patients, with the exception of P1 and P8, may have some degree of either conceptual and/or lexical semantic impairment contributing to their word production difficulties.

As can be seen in Table 2, performance on naming, as measured by both the BNT and the Philadelphia Naming Test (PNT) (Roach et al., 1996) was below normal for all participants. With the exception of P4 on word repetition, performance on word repetition and oral word reading tasks was also below normal for all participants. However, for all patients, performance in at least one of either the repetition or reading tasks was better than their naming performance. This pattern of relative strengths and weaknesses suggests that patients’ phonological processing is relatively intact in comparison to their lexical processing and that, for all patients, their naming impairment appears to be situated at the level of lexical processing or in the connections between lexical and phonological processing.

In addition to accuracy of performance, the types of errors made on the PNT (Roach et al., 1996) were examined (see Table 3). As can be seen, the preponderance of naming errors for most participants was that of omissions. Two patients, P3 and P5, made primarily unrelated word errors and semantically related word errors, respectively. P9 made mostly nonword errors. Unrelated word errors and semantic errors likely stem from the lexical semantic level of processing. In interactive activation accounts of word production (e.g., Dell, Schwartz, Martin, Saffran &
Gagnon, 1997), naming errors characterised predominantly by omissions can be interpreted as indicating a failure to activate a word at the lexical level or as a phenomenon independent of the naming process (Dell, Lawler, Harris, & Gordon, 2004) or even as stemming from the phonological level (Schwartz et al., 2006). If we consider an omission to be indicative of a failure to activate an item at the lexical level and/or the phonological level, then the preponderance of omissions in seven of the patients, and the preponderance of unrelated and semantic errors seen in two patients suggest a deficit consistent with the interpretation we have already provided above. In sum, the pattern of performance on naming and other tests and the analysis of errors in naming all converge on suggesting a deficit at the lexical level and/or in the connections between the lexical and phonological levels (but prior to the phonological level per se) for 9 of the 10 patients. The preponderance of nonword errors seen in P9 suggests a deficit at the phonological level. Taken together with the results of input tasks, above, it appears that this patient may have deficits at multiple levels in the word production system.

Design and treatment stimuli

A single-subject multiple-baseline across behaviours design (McReynolds & Kearns, 1983) was employed. The stimuli consisted of 105 coloured photographs. Each photograph was carefully chosen to be an unambiguous representative of the targeted item. All photographs were pre-tested on a group of non-brain-damaged elderly adults who were fluent speakers of English (n = 20; mean age = 72 years; mean level of education = 15 years) to ensure the photograph elicited the desired target word.

To obtain a list of words to be treated and ensure a stable baseline, participants were first shown all 105 coloured photographs and asked to name them in three consecutive sessions. No cueing or feedback was provided. Responses were scored as correct only if the target word was produced completely accurately. Of the words that were in error in at least two of the three sessions, participants were asked to choose the items that they would like to have treated. Of those words, 30 were chosen and divided into three lists of 10 words each. Participant 1 had fewer items in

<table>
<thead>
<tr>
<th>Participant</th>
<th>Omissions</th>
<th>Formal</th>
<th>Semantic</th>
<th>Mixed</th>
<th>Nonwords</th>
<th>Unrelated</th>
<th>Other</th>
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</thead>
<tbody>
<tr>
<td>P1</td>
<td>22</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>8</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>P2</td>
<td>34</td>
<td>3</td>
<td>19</td>
<td>2</td>
<td>22</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>P3</td>
<td>8</td>
<td>13</td>
<td>19</td>
<td>3</td>
<td>34</td>
<td>46</td>
<td>11</td>
</tr>
<tr>
<td>P4</td>
<td>69</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7</td>
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<td>9</td>
<td>1</td>
<td>40</td>
<td>4</td>
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<td>28</td>
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<td>18</td>
<td>1</td>
<td>11</td>
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<td>3</td>
</tr>
<tr>
<td>P7</td>
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<td>16</td>
<td>2</td>
<td>13</td>
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<td>49</td>
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<td>P8</td>
<td>33</td>
<td>1</td>
<td>10</td>
<td>2</td>
<td>3</td>
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<td>5</td>
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<tr>
<td>P9</td>
<td>4</td>
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<td>7</td>
<td>3</td>
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<td>157</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>3</td>
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</table>

PNT – Philadelphia Naming Test (Roach et al., 1996)
error and it was only possible to construct two lists of six words each. The lists for each participant were equated as much as possible by category, frequency, and number of syllables. In addition, when possible, each list contained up to five words that the participant could name in order to ensure some success during treatment. Note that these words were not considered part of baseline performance.

Treatment schedule and probes of naming performance

The general treatment schedule for each participant was as follows. First, after having established a low and stable baseline over three consecutive sessions, treatment of List 1 words began. Sessions occurred three times a week for approximately 1 hour. Presentation of treated items was randomised at every session.

At the end of every second session, treated items were probed for accuracy using a picture-naming task (with a random presentation of items). The first complete response was scored. A response time of 10 seconds was imposed and no feedback was provided by the examiner. Untreated items (e.g., List 2 and 3 items while List 1 was being treated) were probed for accuracy every three sessions, in order to minimise the effect of repeated measures common to multiple-baseline designs. The items that the participant could name from the outset were not probed.

The criterion for moving to treatment on a subsequent list was 80% correct over 2 consecutive sessions or a maximum of 15 sessions (whichever occurred first). Once treatment on a new list was initiated, accuracy of response to previously treated items was probed every three sessions in order to examine maintenance effects. If a participant did not achieve at least 40% correct on List 2, treatment was discontinued for that individual. The examiner scored all probe sessions on-line.

Treatment

A phonological components analysis chart was used following the protocol of Coelho et al. (2000). The target picture was presented in the centre of the chart and the participant was asked to name it. Irrespective of his/her ability to name the picture, the participant was asked to identify five phonological components related to the target item:

- **Rhymes**: “What does this rhyme with?”
- **First sound**: “What sound does it start with?”
- **First sound associate**: “What other word starts with the same sound?”
- **Final sound**: “What sound does it end with?”
- **Number of syllables**: “How many beats does the word have?”

For each component targeted, if a participant could not spontaneously provide a response, he/she was asked to choose one from a list of up to three. The choices were visually presented on a card and read aloud by the examiner. Once a response relating to the phonological component was provided (or chosen) by the participant, the examiner wrote that response on the chart. (Note that at no point in the treatment protocol was the target word provided in written format). See Figure 1. After all components were generated, the participant was asked to name the target again. If the participant was correct, the examiner provided positive feedback and indicated, “Yes, that’s right. It’s a ____”. If the participant was incorrect, the
Irrespective of whether or not the participant was able to provide the correct response, all phonological components were reviewed by the examiner. Following the review of the phonological components of the targeted item, the participant was asked once again to name the target. Similar to the procedure just detailed, if the participant was correct, the examiner provided positive feedback and indicated, “Yes, that’s right. It’s a ____”. If the participant was incorrect, the examiner provided the correct response and encouraged the participant to repeat it. This procedure resulted in the provision of the correct name a total of two times by the examiner, whether or not a participant could name the item without support (see Figure 2).
After the first session with each new list to be treated, identification of the phonological components of the target item proceeded as follows: First, the participant was asked to provide a response according to the component categories listed above. However, if the participant was unable to spontaneously provide a response, the examiner provided the participant with the word that he/she had previously chosen for that category.

Reliability

All treatment sessions were audiotaped and 20% of the sessions were videotaped to allow for a measure of reliability of the scoring of probes for treated items and the administration of the therapy, respectively.²

Scoring of probes. For each participant separately, 20% of the total number of probes taken was randomly selected for re-scoring by an individual other than the original examiner. Point-to-point agreement for scoring of accuracy of response was determined and found to be quite high (mean = 96.4% agreement; range: 84–100%).

Administration of therapy. For each participant, two independent raters (other than the original examiner) viewed all videotaped therapy sessions (representing 20% of all therapy sessions for each individual). The first 10 minutes of each tape was disregarded and then four consecutive presentations of target words were rated. The raters scored the administration of the therapy according to: (1) accuracy of presentation of the stimuli (both of the target picture for naming and the provision of the phonological component options); and (2) the provision of appropriate feedback (for initial naming of the target picture, in reviewing the components after the presentation of all five of them, and for the final naming of the target picture). Point-to-point agreement for all five dimensions rated, for all patients, was high (mean = 98.2%; range = 90–100%).

A measure of generalisation to untreated items was provided by performance on the Philadelphia Naming Test (Roach et al., 1996) pre- and post-therapy.

RESULTS

Treatment

The results are presented in Figures 3–12, in multiple-baseline formats with percent accuracy as the dependent variable. Initial baseline performance for 8 of the 10 participants on all lists was low and stable. While still relatively low, the initial baselines for participants 6 (Figure 8) and 8 (Figure 9) showed some variability.

As is evident at first glance at Figures 3–7, and 9, six of the ten participants (P1, P2, P3, P4, P5, and P8) demonstrated robust treatment effects on all three lists treated. Participant 6 (Figure 8) also demonstrated clear treatment effects for Lists 1 and 2. However, the baseline performance for List 3 showed a substantial increase in percent correct just prior to treatment resulting in a loss of experimental control and, therefore, precludes us from being able to unequivocally claim a treatment effect for this list. Participants 7, 9, and 10 (Figures 10–12) did not demonstrate a treatment

² Reliability for P1 was based on audiotape and not videotape due to an equipment failure.
effect. All three did not meet the minimum requirement of at least 40% correct on List 2; hence treatment was terminated for these participants.

The visual analysis of the data indicating a treatment effect is supported statistically using the two standard deviation band method—a procedure recommended by Ottenbacher (1986) when there are a small number of data points in the baseline. For Lists 2 and 3, critical cut-off values set at 2 SD above the baseline mean were determined for each individual separately. Performance in treatment was considered improved if at least two successive points exceeded the critical cut-off values. For the seven participants who improved in treatment, the cut-off value is represented in Figures 3–9 by a horizontal dotted line. It should be noted that, with the exception of Participants 6 and 8 (Figures 8 and 9, respectively), it was not possible to submit Lists 1 to this analysis, as there was zero variability in the initial baselines. As can be seen, the treatment effect for Lists 2 and 3 for all participants, except P6, indicates improvement. For P6, while the treatment effect for List 2 shows improvement, as discussed above, the baseline performance for List 3 for this participant showed a substantial increase in percent correct just prior to treatment, resulting in an extremely high 2 SD value for this list. Treatment effects for List 1 for Participants 6 and 8 also indicated improvement using this method.

Although only one data point is available in the 4-week follow-up period, this method also supports the finding of maintenance of treatment effects for Lists 1 for P6 and P8 (not possible to calculate for the other participants as noted above), Lists 2 for all participants who improved except P1, and Lists 3 for all participants who improved except P5 and P6 (Note: P1 had no List 3).

Effect sizes were also calculated, where possible, by comparing the difference between the treatment and baseline means as a function of the baseline standard deviation, following the method of Busk and Serlin (1992). In some instances, mostly for Lists 1, it was not possible to calculate an effect size due to zero variability in the
baseline phase. Several recommendations exist for determining whether effect sizes are large, medium, or small for single-subject studies. Busk and Serlin (1992) deem effect sizes greater than 2 to be large. Beeson and Robey (2006) have recently recommended that effect sizes of 2.6, 3.9, and 5.8 correspond to small, medium, and large treatment effects. Table 4 shows the mean effect size across treatment lists (for which the calculation was possible) for the participants who demonstrated a treatment effect. As can be seen, according to the Busk and Serlin (1992) criteria, all averaged effect sizes for all patients were found to be large. However, according to the Beeson and Robey (2006) criteria, effect sizes span the range from large to small.

Generalisation of treatment for naming to untreated items

Percent correct on the Philadelphia Naming Test (Roach et al., 1996) pre- and post-treatment for each participant is shown in Table 5. The McNemar Test for comparison of two related samples was used to assess the difference. A significant difference ($p < .01$, one-tailed) was found for three of the seven participants (P2, P3,
who demonstrated a treatment effect. The change for P10 was also found to be significant. However, since both his initial and final scores were extremely low (1% and 9% correct, respectively), and he did not improve in treatment, this effect is difficult to interpret. A group analysis of pre- and post-treatment percent correct scores on the PNT for those participants demonstrating a treatment effect was also conducted and found to be significant, \( t(6) = -2.4, p < .05, \) one-tailed.

**Figure 5.** Percent correct for Participant 3.

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3 Note that there was a small amount of overlap between treatment and PNT items for all participants. However, this overlap made no difference to the pattern of findings for generalisation. When McNemar tests were performed with the overlap items removed, the results were exactly the same.

**Relationships between pre-treatment tests and response to treatment**

A final analysis was conducted to examine the relationships between scores on pre-treatment tests and response to treatment using a Pearson correlation coefficient. Response to treatment was defined as the mean performance on probes during treatment sessions across all lists treated, per participant. Significant correlations...
(\(p < .01\), one-tailed) were found between response to treatment and scores on the BNT, and Oral Reading (PALPA 53). A less severe naming impairment and better oral reading resulted in better performance during treatment. A trend indicating a positive relationship (\(p = .065\), one-tailed) between treatment performance and scores on Word Repetition (PALPA 53) was also found. Finally, a trend towards a negative relationship (\(p = .065\), one-tailed) between treatment performance and a semantic deficit (as measured by the difference in performance on the “a” (with semantic distractors) and “b” (without semantic distractors) versions of the Spoken Word – Written Word subtest (PALPA 52)), was found. Despite the good range in response to treatment evidenced by the participants (4.3–88.3% correct), it is acknowledged that due to the small sample size, the power of this analysis is limited.

The percentage of instances where each participant generated the phonological components independently, without aid from the examiner, for each list of treated items, is shown in Table 6. While the number of potential non-orthogonal comparisons between lists precludes a statistical analysis because of the reduced power inherent in such multiple comparisons, a few points are of interest. First, it should be noted that, with the exception of P8, the percentage of instances of independent generation of components for List 1 was less than 50%. Interestingly, 7
of the 10 participants (2 of whom had not demonstrated a treatment effect) then showed a substantial increased percentage between Lists 1 and 2, with Participants 2, 4, and 5 showing a modest increase between Lists 2 and 3. When looking at the mean percentage of instances across lists for each participant, five of the seven individuals who improved in treatment generated the components independently at least 50% of the time; whereas, all three participants who did not show a treatment effect independently generated the components less than 50% of the time.

**DISCUSSION**

The effectiveness of a phonological components analysis approach to the remediation of naming deficits in aphasia was investigated. The approach, focusing on the phonological properties of words, was modelled after the traditional semantic feature-based therapy following the protocol of Boyle, Coelho, and colleagues (e.g., Boyle, 2004; Boyle & Coelho, 1995; Coelho et al., 2000; Conley & Coelho, 2003). The results were very clear in demonstrating the effectiveness of this approach. This finding is in line with recent evidence (e.g., Best et al., 2002; Hickin et al., 2002;
Raymer et al., 1993; Wambaugh, 2003; Wambaugh et al., 2004) attesting to the effectiveness of a phonologically based approach to anomia. In the present study 7 of 10 participants demonstrated notable improvements in naming treated items and, with the exception of 1 participant, good maintenance of baseline performance to untreated items, thereby demonstrating good experimental control. In addition, the effects of treatment were found to be long lasting as all seven participants evidenced some level of maintenance of treatment effects at 1-month follow-up. This finding is in contrast to a long-held view that the effects of phonological treatment for anomia are short lived (e.g., Howard et al., 1985), although it must be acknowledged that the use of picture stimuli in this study meant that there was also a semantic component to our therapy approach. As discussed by Hickin et al. (2002), one possible reason for the lack of maintenance with phonologically based approaches is that traditionally, with phonological treatment (as opposed to semantic), the cue is simply provided (for instance with repetition or first sound cueing). They argue that perhaps a more active engagement on the part of the participant in his/her therapy is necessary to produce longer-lasting effects. Such an explanation may help to explain
our results; the generation of the phonological components for PCA therapy required of the participants such an engagement.

This notion that the active participation of an individual with aphasia to access words is important for improving naming skills is not new (e.g., Fillingham, Sage, Lambon Ralph, 2005, 2006; Francis, Clark, & Humphreys, 2002; McNeil, Small, Masterson, & Fossett, 1995; Spencer et al., 2000; Wiegel-Crump & Koenigsknecht, 1973). For instance, McNeil et al. (1995) found improved naming with a task in which the participant was instructed to provide synonyms and antonyms for a target word. Similarly, Spencer et al. (2000) asked their patient to answer questions related to semantic and phonological aspects of the target word and found improvement in naming post-treatment. Francis et al. (2002) attributed the success of their “circumlocution-induced naming” and, importantly, the generalisation of the treatment effect to untrained items, to the active and independent role played by their patient in treatment. Our results are consistent with this view. Five of the seven individuals who demonstrated a treatment effect using PCA were able to generate the phonological components unaided by the examiner at least 50% of the time.

Figure 9. Percent correct for Participant 8.
(averaged across the three lists); whereas for all three of the individuals who did not demonstrate a treatment effect this ability was at less than 50%. While these results are intriguing, the notion that active choice or engagement in this study promoted maintenance of treatment effects is speculative as this factor was not specifically manipulated within the study. Indeed, future studies are warranted to examine this notion as a potential factor to success in a more systematic manner.

In addition to the relative longevity of the treatment effect produced by the PCA therapy, generalisation of this effect to untreated items, as measured by performance on the PNT pre- and post-therapy, was noted for three (P2, P3, P4) of the seven participants who demonstrated a treatment effect using this protocol. Interestingly, P2 and P4 also demonstrated some improvement for untrained sets during baseline. While admittedly a modest result and contrary to a prevailing view in the literature that phonological therapy is item specific (e.g., Hickin et al., 2002; Miceli et al., 1996), it is nonetheless consistent with some findings of generalisation to untreated items following phonological therapy (e.g., Franklin, Buerk, & Howard, 2002; Robson et al., 1998). Howard (2000) and others have argued that no generalisation
to untreated items should occur when the deficit is the mapping from semantics to phonology, precisely because this mapping is word specific. This notion appears to be based on the assumption that entries at the phonological level are discrete (i.e., item specific) in contrast to items in the semantic system, which are interconnected (Miceli et al., 1996). However, Robson et al. (1998) demonstrated generalisation to untreated items after phonological therapy in an individual who had a similar diagnosis to those in the present study. Francis et al. (2002) and Spencer et al. (2002) also demonstrated generalisation to untreated items in participants diagnosed with deficits in activating phonology from semantics, although the treatments in these two studies were not primarily phonological. Taken together, our results, and those in the studies just mentioned, suggest that, in line with interactive activation models (e.g., Foygel & Dell, 2000), the phonological level may be organised in a manner more similar to the semantic system than previously thought: when activation of the requisite phonological components is reached for correct (and improved) production of a target word, activation within the lexicon can spread to other entries. Indeed, there is evidence from the phonological priming literature for both normal

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**Figure 11.** Percent correct for Participant 9.
individuals (e.g., Milberg, Blumstein, & Dworetzky, 1988) and individuals with aphasia (Baum & Leonard, 1999) that would support such an organisation.

It is also important to note that the finding of generalisation effects using PCA is consistent with those of SFA (Boyle, 2004), after which PCA is modelled. It may be argued that both approaches teach a strategy for naming, rather than simply a relearning of words, which may contribute to generalisation of effects to untreated items.

**Potential factors influencing success**

A number of factors must be considered in attempting to explain the response to treatment of the participants in this study. First, the notion of severity must be advanced as a potential contributing factor to the differences in performance between participants in the present study. Based on the results of the correlational analysis, pre-treatment performance on the BNT (Goodglass et al., 2001) was significantly related to response to treatment. When looking at the individual profiles of participants, it is obvious based on performance on this measure that the
three participants who did not improve were among those with the most severe naming impairments.

The correlational analysis also identified performance on the oral reading subtest of the PALPA (Kay et al., 1992) as being positively related to response to treatment.

### TABLE 4
Mean effect size across treatment lists

<table>
<thead>
<tr>
<th>Participant</th>
<th>Mean Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>7.20</td>
</tr>
<tr>
<td>P2</td>
<td>2.65</td>
</tr>
<tr>
<td>P3</td>
<td>8.70</td>
</tr>
<tr>
<td>P4</td>
<td>2.80</td>
</tr>
<tr>
<td>P5</td>
<td>3.00</td>
</tr>
<tr>
<td>P6</td>
<td>3.47</td>
</tr>
<tr>
<td>P8</td>
<td>6.80</td>
</tr>
</tbody>
</table>

### TABLE 5
Percent correct on the PNT pre- and post-therapy

<table>
<thead>
<tr>
<th>Participant</th>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>72</td>
<td>77</td>
</tr>
<tr>
<td>P2</td>
<td>47</td>
<td>59*</td>
</tr>
<tr>
<td>P3</td>
<td>23</td>
<td>61*</td>
</tr>
<tr>
<td>P4</td>
<td>52</td>
<td>63*</td>
</tr>
<tr>
<td>P5</td>
<td>49</td>
<td>54</td>
</tr>
<tr>
<td>P6</td>
<td>64</td>
<td>69</td>
</tr>
<tr>
<td>P7</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>P8</td>
<td>69</td>
<td>73</td>
</tr>
<tr>
<td>P9</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>P10</td>
<td>1</td>
<td>9*</td>
</tr>
</tbody>
</table>

*Difference significant (p < .01, one-tailed), McNemar test

PNT – Philadelphia Naming Test (Roach et al., 1996)

### TABLE 6
Percentage of instances where each participant generated phonological components independently

<table>
<thead>
<tr>
<th>Participant</th>
<th>List 1</th>
<th>List 2</th>
<th>List 3</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>41</td>
<td>68</td>
<td>no list</td>
<td>55</td>
</tr>
<tr>
<td>P2</td>
<td>49</td>
<td>72</td>
<td>76</td>
<td>66</td>
</tr>
<tr>
<td>P3</td>
<td>43</td>
<td>58</td>
<td>58</td>
<td>53</td>
</tr>
<tr>
<td>P4</td>
<td>49</td>
<td>61</td>
<td>73</td>
<td>61</td>
</tr>
<tr>
<td>P5</td>
<td>14</td>
<td>14</td>
<td>22</td>
<td>17</td>
</tr>
<tr>
<td>P6</td>
<td>42</td>
<td>47</td>
<td>48</td>
<td>46</td>
</tr>
<tr>
<td>P7</td>
<td>31</td>
<td>31</td>
<td>nt</td>
<td>31</td>
</tr>
<tr>
<td>P8</td>
<td>71</td>
<td>82</td>
<td>77</td>
<td>77</td>
</tr>
<tr>
<td>P9</td>
<td>19</td>
<td>26</td>
<td>nt</td>
<td>23</td>
</tr>
<tr>
<td>P10</td>
<td>32</td>
<td>47</td>
<td>nt</td>
<td>40</td>
</tr>
</tbody>
</table>

nt = not tested
This result is similar to that found by Hickin et al. (2002) who noted a significantly positive correlation between oral word reading and overall improved naming ability (following both phonological and orthographic cueing) for eight individuals with aphasia. Raymer et al. (1993) also found oral reading abilities to be predictive of successful phonological treatment for naming. They suggested that oral reading abilities might reflect the potential phonological production abilities available if the activation of the phonological level from the semantic level was more reliable or consistent during naming. This view coincides well with our data. It is possible therefore, that one of the specific benefits of the PCA treatment was in enhancing and strengthening the association between lexical semantics and the phonological word form, thus allowing for correct production.

There was a positive trend noted in the correlational analysis between word repetition and response to treatment and a negative trend between a lexical semantic deficit and response to treatment. The relationship with word repetition may well reflect the benefit to naming that can be augmented when a patient can access phonology. The suggestion that there may be negative consequences to naming associated with a lexical semantic deficit is in keeping with what others have also found (e.g., Renvall, Laine, & Martin, 2005). However, this suggestion is tempered by the finding that our phonologically based approach proved effective for addressing the naming impairments of patients who all had some degree of lexical-semantic impairment. This apparent contradiction highlights the importance of better delineating the exact nature of a lexical-semantic impairment and the implications for such an impairment for success in treatment (see Renvall et al., 2007).

Further to the issue of level of deficit, it should be noted that because P9’s deficits appeared to be more phonologically based than the other participants, this patient might have been expected to respond well to the PCA treatment. However, since her deficits were not confined to the phonological level, and the severity of her naming impairment was great, multiple factors may have contributed to the lack of improvement in this patient.

Finally, aphasia type must be considered as a potentially contributing factor to success. In this small sample of 10 individuals, aphasia type does not appear to have been a major factor. Although most patients who improved in treatment were nonfluent, with one exception, among those who were not successful there were both nonfluent and fluent patients. All these issues certainly warrant further investigation.

CONCLUSION

The present investigation was successful in demonstrating the effectiveness of a new phonological approach to the remediation of naming deficits in aphasia, consistent with recent work attesting to the same (e.g., Hickin et al., 2002; Wambaugh, 2003; Wambaugh et al., 2004). It was also successful in supporting the notion that a components analysis treatment protocol (similar to a semantic feature-based treatment) is useful in strengthening activations within the lexical system, evidently with the result of longer-lasting effects. The development of this phonologically based treatment approach, comparable to the semantic feature analysis approach, and its demonstrated effectiveness, will allow for future studies comparing the relative effects of both types of therapies within the same individuals, with the
ultimate goal of better elucidating which type of therapy is best for which type of naming deficit.

As with all investigations of treatment protocols, a number of potentially contributing factors to success remain to be explored. For instance, it is still unclear as to the optimal type and number of components necessary to elicit correct production. The specific role of active choice or engagement in a task to maintenance of treatment effects and generalisation also remains to be investigated. And finally, patient factors that contribute to success warrant further investigation.

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