Naming Facilitation Therapy: Investigating the Facilitation Effect for the Treatment of 500 Words

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Abstract

Background: Previous research has shown that Facilitation Therapy improves word retrieval in individuals with anomia (Nickels 2002b). Facilitation refers to the strengthening of neurological mappings between semantic and phonological lexicons when both are simultaneously active, resulting in enhanced word retrieval (Howard 2000). Jacoby (1983) indicates that repetition effects are due to the retrieval of context-specific information about the priming episode (a function of episodic memory) rather than changes in the accessibility of lexical knowledge.

Objectives: 1) Investigate the efficacy of facilitation therapy for the treatment of 500 words for 5 clients with anomia over the course of 5 weeks. 2) Investigate the underlying mechanism of facilitation therapy through identification of primacy and recency effects, which would indicate recruitment of episodic memory.

Methods: An item-specific design included 500 treatment items and 100 untreated items, and additional untreated items from the BNT and PALPA. The facilitation task used was whole-word repetition alongside a pictorially presented stimulus of the target word. Pre and post treatment results were compared for the group and individual participants. This study presents the group results and individual results for two participants: AB and POD.

Results: Numbers in the n=500 treated set improved for the group but were not significant. POD and AB improved significantly on the n=500 treated set. POD’s untreated n=100 set remained stable. Unexpectedly, AB’s n=100 untreated set improved significantly. Primacy and recency effects were not evident in both POD and AB’s results, indicating that gains are not attributable to episodic memory recruitment.

Conclusions: Small sample size and increased variation amongst participant’s abilities may have hindered attainment of significance for the group. POD’s gains are directly attributable to facilitation; AB’s generalization indicates that a facilitation effect was involved, however this alone cannot be directly attributed to her improvement. Contributing factors are discussed.

Keywords: Anomia, Facilitation, Episodic Memory, Primacy and Recency.
Introduction
Anomia is a symptom of aphasia, and can be very debilitating to daily functioning. An individual may experience increased and ongoing frustration when he or she cannot retrieve a word for spoken production, which, prior to his or her brain injury, required little effort. Therapy for anomia aims to remediate word-finding errors in order to reduce the individual with anomia’s dysfluency, as this can be reported as one of the most distressing aspects of his or her impairment (Nickels 2002b). The aim of this review is to explain the different presentations of anomia and their implications for treatment, with increased emphasis on the mechanism of facilitation.

Language Models
The rationale for anomia treatment stems from language models depicting the trajectory of word retrieval. An individual with word-finding difficulties may experience a breakdown at a particular level of the model, which will impact the nature of their naming errors (Miceli et al 1996; Nettleton and Lesser 1991).

Following the cognitive theoretical model of speech production, successful naming involves three main levels of activation: the ‘semantic lexicon’, ‘phonological output lexicon’ and ‘phonological output buffer’ (Nickels 2002a). Figure 1 presents an illustration of a spoken naming model, based on that provided in Howard et al (2006).

Howard et al (2006) indicate that the process of phonological assembly occurs at the level of the phonological output buffer, which generates specification that can be used to drive articulatory programming. Impairments to the ‘phonological output buffer’ may result in phonological errors related to the target word form, such as phoneme substitution errors, which are typically close in approximation to the manner and position of the target sound (Caramazza et al 1986). Thus, phonological output buffer impairments are not classified as a ‘word-retrieval’ deficit, but rather a ‘word-production’ deficit (Best et al 2013).

A deficit to the semantic lexicon reflects an incorrect, incomplete, or underspecified semantic representation that causes impaired word meaning (Hodges et al 1995), whereas a deficit to the phonological output lexicon causes impaired retrieval of the phonological form from semantics (Howard 1995). Functional neuroimaging studies have identified the
cortical regions that mediate the processes of word retrieval and production, which show that the semantic and phonological components in naming engage different neural regions (Indefrey 2011; Indefrey and Levelt 2004). Some researchers suggest that remediation of word-finding difficulties requires increased focus on the domain corresponding to the individual’s level of impairment (Miceli et al 1996; Nettleton and Lesser 1991). However, others propose that the difference between semantic and phonological approaches is overstated (Howard 2000), as stimulation at one level (eg, the phonological lexicon) also stimulates processing at the other (eg semantic lexicon) (Fridriksson et al 2007).

Figure 1. A model of the processes involved in picture naming and spoken word comprehension (Based on model retrieved from Howard et al (2006))

Therapy Approaches
Therapies for anomia typically involve semantic and/or phonologically based tasks. Tasks such as judging semantic relatedness of items, categorizing objects of pictures, matching words to pictures, describing semantic features, and providing synonyms and antonyms have been considered to target the semantic lexicon level of processing (Wambaugh et al 2001; Boyle and Coelho 1996; Drew and Thompson 1999). Tasks such as performing rhyme judgements, using word initial-sound cues, repeating names of target items, and generating
rhyming words have been considered to target the phonological-output lexicon level of processing (Wambaugh et al 2001; Howard et al 1985; Raymer et al 1993).

Semantic Features Analysis
Semantic Features Analysis (SFA) therapy targets semantic processing through exploration of a target’s semantic attributes. Activation of a target word’s semantic features may increase the probability of the target word reaching its activation threshold required for retrieval (Boyle and Coelho 1995). In this approach, the individual with anomia is provided with a picture and requested to name it, and then encouraged to describe the semantic features of the target item, prompted by ‘is a...’, ‘has a...’, ‘is used for...’ etc., in order to generate features relating to its group, properties, use, action, location, and associations (Nickels 2002b; Boyle and Coelho 1995). Coelho et al (2000) argue that SFA manifests as a facilitation approach by activating the semantic network that surrounds the target word above threshold, thereby facilitating retrieval. Other researchers argue that SFA is better viewed as a teaching strategy, such that thinking about a target word’s semantic associates may cue retrieval of the target word (Nickels 2002b).

Facilitation Therapy
Facilitation therapy enhances word retrieval by strengthening the connections between semantic and phonological domains (Nickels 2002b). Facilitation tasks typically involve increased focus on the target word’s phonological form (eg., word repetition, cueing), or semantic representation (eg., Matching a word to one of a choice of pictures) (Nickels 2002b; Miceli et al 1996; Nettleton and Lesser 1991). Despite these separated approaches, some researchers argue that both phonological and semantic-based tasks have their effects in exactly the same way, by strengthening the mappings between the semantic and phonological lexicon. This is reasonable, considering that most language tasks usually require processing of both domains to some degree (Howard 2000; Nickels 2002b).

Evidence for Facilitation: Repetition Priming Effects in Normal Populations
In repetition priming, subjects are faster and more accurate at responding to a word if it is preceded by the same word than if it is preceded by a different, unrelated word (Bodner and Masson 2001). In this regard, repetition priming facilitates retrieval of a target word.
Monsell et al (1992) tested bilingual individuals of Welsh-English in a picture-naming task in Welsh, where half of the words were primed by their earlier production in Welsh in response to their Welsh definition, or by production in English in response to their English definition. The authors found a substantial facilitation effect from prior production in the same language, but none from prior production in the other language that differed in phonological form. Monsell et al claim that priming is not established through repeated activation of a meaning when a different phonological form is produced, or, from repetition of the same phonological form in response to different meanings. Rather, they conclude that priming is localized within the connection between a word’s meaning and its phonological form.

Wheeldon and Monsell (1994) used homophones to isolate their target word’s phonological form from its semantic representation, and found that prior production of the homophone did not facilitate production of the target word in a picture identification task. Wheeldon and Monsell conclude that facilitation observed for repeated production of the same word cannot be associated with repetition of the phonological form per se, as this must be produced in conjunction with the activation of its semantic specifications.

**Naming Facilitation Therapy in Individuals with Aphasia**

Lorenz and Ziegler (2009) hypothesized that prescribing either a semantic or phonological facilitation task to an individual with anomia with a corresponding level of impairment would optimize treatment results. Their findings contradicted their hypothesis, as participants with semantic deficits were observed to benefit from the phonological approach, and participants with post-semantic deficits were observed to benefit from the semantic approach. Lorenz and Ziegler conclude that facilitation therapy is beneficial for individuals with either a semantic or phonological impairment.

Howard et al (2006) studied semantic facilitation using a word-to-picture matching task on individuals with anomia. Each stimulus cue incorporated either coordinate distractors (drawn from the same semantic category), associate distractors (holds a thematic relationship to the target), or unrelated distractors. They hypothesized that if word-to-picture matching affects naming by drawing more precise distinctions between members of a category, there should be greater facilitation for coordinate than unrelated distractors,
and this difference should be more pronounced in individuals with greater semantic impairment. Results showed that individuals with less semantic impairment increased their naming performance following the associative distractor task, but not following the coordinate and unrelated distractor tasks. Howard et al concluded that these results are inconsistent with claims that discrimination amongst more closely related distractors results in greater facilitation.

Best et al (2002) investigated facilitation for repetition, phonological, and rime cues, and found a cue effect for immediate and delayed naming. In contrast to previous studies that found contradictory results (Patterson et al 1983), this study involved the presence of the stimulus’ picture when the cue was presented. Best et al suggest that the presence of the target word’s picture during their naming task supported semantic processing to a greater degree than repetition of the phonological form in isolation. Thus, facilitation was enhanced by the presentation of each word’s semantic representation.

In the second experiment included in Best et al’s study, the authors grouped participants based on the nature of their naming deficit: those with more and less of a semantic impairment and those with more and less of a phonological impairment. The effect of cueing facilitation on these four groups was analyzed. The authors found that there was a greater facilitation effect for participants with less phonological impairment and less semantic impairment than the remaining groups, indicating that individuals with a word-retrieval deficit between the mappings of semantics and phonology are most likely to benefit from a lasting facilitation effect. The authors also found that there was no significant relationship between the size of the facilitation effect and anoma severity, indicating that facilitation therapy may be appropriate to use irrespective of severity.

**An Alternative Method for Facilitation**

Bodner and Masson (2001) suggest two different models for word recognition: 1) A memory phenomenon that reflects an interaction between memory for prior experience and current encoding conditions. 2) A reliance on the activation of special representations that are entirely distinct from our memories for particular prior experiences with words. The latter supports the workings of the language model described in this review, whereas the former reflects recruitment of the episodic memory. As Jacoby (1983) argues,
repetition effects are due to the retrieval of context-specific information about the priming episode, rather than changes in the accessibility of lexical knowledge. However, Wheeldon and Monsell (1992) suggest that this is likely plausible only if cognitive operations are slow and inefficient, relative to the episodically mediated retrieval of the same information. In this regard, individuals with aphasia, who likely present with slow and inefficient language processing, may be susceptible to using their episodic memory to aid in word retrieval, which may inadvertently reflect a facilitation effect.

A different study by Fredriksson et al (2007) includes the presentation of patient EG, who showed increased activity in his left precuneus on an fMRI scan following improvements in naming from facilitation treatment for his anomia. Cavanna and Trimble (2006) indicate that the precuneus plays an important role in episodic memory retrieval, and increased precuneus activity following treatment could reflect reference to specific stimuli presented during treatment. Effectively, EG may have recruited his episodic memory as one of perhaps several strategies to improve his naming performance (Fredriksson et al 2007).

Size of Treatment Set
Snell et al (2010) investigated treatment sizes for anomia therapy, between a small set (n=20) and a large set (n=60), on 13 individuals with anomia. The authors found proportionate improvements between the small (n=20) and large (n=60) set sizes at post-treatment, resulting in a greater number of words learned in individuals who were provided the larger set. This study suggests that irrespective of aphasia severity, when more words are provided, more words are learned. Kelly (unpublished) compared naming facilitation therapy for proportionately larger treatment sets than those used in Snell et al’s study (small set: n=50; large set: n=500), and found that a similar number of words were learned irrespective of treatment size. Both Snell et al and Kelly’s findings suggest that individuals with aphasia may tolerate and benefit from larger treatment sizes during therapy.

Generalization
Generalization is significantly limited in a whole word rehabilitation paradigm (Plaut 1996). Kendall et al suggest the need to treat “hundreds, if not thousands of words”, (2008, 3) in order to meaningfully alter daily communication. Research has indicated that individuals
with anomia are able to tolerate a large number of words (Snell et al 2006; Kelly unpublished). Therefore, more research on the efficacy of treating a large number of words on individuals with anomia is warranted.

**Conclusion**
Facilitation therapy is proven to be effective at improving word finding in individuals with anomia, though generalization to untreated words is limited. In this regard, treatment of a large number of words is advantageous as it may compensate for this limited generalization. Naming facilitation was proven to be equally effective at treating a small and large number of words. However, whether the underlying mechanism of naming facilitation therapy for the treatment of a large number of words is attributable to the facilitation effect has yet to be determined.

**Study Aims and Objectives**
Previous research by Kelly (unpublished) found that a similar number of words could be learned following facilitation therapy when comparing a small treatment set (n=50) and a large treatment set (n=500). This study aims to contribute to this research by investigating:

1) The efficacy of facilitation therapy for the treatment of 500 words for 5 clients with anomia (n=5) over the course of five weeks.

2) The underlying mechanism of facilitation therapy through identification of primacy and recency effects, which would be indicative of episodic memory recruitment.

**Method**
**Study Outline**
Five individuals with anomia participated in this study. An item-specific design with 500 treated items, 100 untreated items, and additional control items from the Boston Naming Test (BNT) and Psycholinguistic Assessment of Language Processing in Aphasia (PALPA) were used. The BNT included treated and untreated items, and the PALPA included untreated items. Thus, these assessments were readministered at post-treatment to increase the validity of outcomes evident on the n=500 treated and n=100 untreated sets for each participant. The 500 words were divided into five sets of 100 words. Each participant was prescribed a different treatment set that was treated exclusively each week.
Pre treatment assessment occurred over two weeks and the treatment phase was 5 weeks in duration. A blind assessor obtained post-treatment outcomes on the eighth and final week, to facilitate objective assessment of word production accuracy at post-treatment, increasing the reliability of each participant’s results.

The following hypotheses were tested:

H0: There will be no change between baseline and post-treatment for the 500 treated items
H1: There will be a change between baseline and post-treatment for the 500 treated items
H0: There will be no change between baseline and post-treatment for the untreated items
H2: There will be a change between baseline and post-treatment for the untreated items
H0: There will be no change between baseline and post-treatment for the BNT and PALPA control items
H3: There will be a change between baseline and post treatment for the BNT and PALPA control items
H0: There will be no differences between pre-treatment and post-treatment for treated items relative to week treated
H4: There will be a significant increase in treatment sets administered during the first and last week relative to the remaining treatment sets, indicating primacy and recency effects

Participants

Eight participants with aphasia were sourced from the Health Service Executive (HSE). Ethical approval was obtained for n=8 subjects by Limerick University Hospital’s Ethics Committee. Three individuals were unable to participant in this study, resulting in a total of five participants. Written consent was obtained from each participant prior to initial assessment.

Each participant had their non-verbal, receptive and expressive communication assessed:

Cognitive Non-verbal Assessment

*Ravens Matrices (Part A) and the Clock Drawing Test*
Assessed each participant’s visual spatial abilities to ensure that they were able to interpret the pictorially presented treatment words; measured each participant’s cognitive performance to determine whether their anomia was affected by a more general cognitive problem.

**Receptive Language Assessment**

*Comprehensive Aphasia Test- Word to Picture Matching*

Probed for semantic or phonological auditory comprehension deficits.

**Expressive Language Assessment**

*Real word repetition*

Excluded the presence of a phonological assembly deficit, and ensured that each participant could accurately repeat target stimuli.

*BNT*: n=60;

Determined the nature and severity of each participant’s anomia.

*PALPA*: n=60;

Determined the severity of each participants’ anomia

A brief description for each participant and their corresponding scores on the above named assessments are presented in Table 1.

Selection Criteria for this study was as follows:

1) More than 12 months post CVA to lessen the possibility of spontaneous improvement

2) Anomia characterized by a score between 10-70% on the BNT

3) Native English Speakers

4) Not receiving any speech and language intervention for the duration of the present study

5) No deficit at the level of phonological assembly (see figure 1) so that the client can accurately repeat treatment words during therapy

6) Score of greater than 3 on the clock drawing test indicating adequate cognitive ability for this therapy approach
All participants met our selection criteria for this study.

This study describes the results of the group analysis as well as the individual analyses for participants AB and POD. More detail is thus given about these two participants.

**Participant AB:** AB is a 74 year old female diagnosed with aphasia, post-CVA. She lives by herself in her home, and was receiving Speech and Language Therapy (SLT) treatment prior to this study. She is taking medication for her blood pressure. No previous SLT reports were obtained. Her language profile is as follows: AB presented as non-fluent during conversational speech, with overt word-finding difficulties. She scored 26/32 on the CAT-Comprehension of Spoken Words subtest, and 30/32 on the CAT- Repetition of Words subtest. She did not present with overt signs of speech difficulties throughout the assessment process. However, during the therapy phase, Ann presented with clinical signs of apraxia, characterized by groping, phonological distortions and substitutions resulting in inaccurate repetitions. The severity of her symptoms varied per week, where some days she had consistently moderate difficulty repeating target words, and others very mild to no difficulty was observed. AB scored 15/60 on the BNT, with errors characterized mostly by phonological paraphasias (8) and neologisms (9); while semantic paraphasias appeared less frequently (4). Phonemic cues increased AB’s ability to produce the target word by 13% (6/45). Based on these results, AB is diagnosed with anoma characterized by impairment at the level of the phonological lexicon and/or between the semantic and phonological lexicons.

**Table 1: Pre-Treatment Assessment Scores for group (n=5).**

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>POD</th>
<th>JM</th>
<th>MOB</th>
<th>GB</th>
<th>AB</th>
<th>Potential³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>M</td>
<td>M</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>Time post-CVA (months)</td>
<td>120</td>
<td>120</td>
<td>36</td>
<td>30</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Raven’s Matrices Part A</td>
<td>8</td>
<td>9</td>
<td>11</td>
<td>12</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Clock Test</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CAT: Comprehension¹</td>
<td>21</td>
<td>20</td>
<td>27</td>
<td>28</td>
<td>26</td>
<td>30</td>
</tr>
<tr>
<td>CAT: Repetition ²</td>
<td>26</td>
<td>31</td>
<td>29</td>
<td>27</td>
<td>30</td>
<td>32</td>
</tr>
<tr>
<td>BNT</td>
<td>15</td>
<td>12</td>
<td>20</td>
<td>26</td>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>PALPA</td>
<td>34</td>
<td>22</td>
<td>39</td>
<td>41</td>
<td>38</td>
<td>60</td>
</tr>
<tr>
<td>Treated Items</td>
<td>109</td>
<td>73</td>
<td>227</td>
<td>299</td>
<td>152</td>
<td>500</td>
</tr>
<tr>
<td>Control Items</td>
<td>22</td>
<td>20</td>
<td>50</td>
<td>68</td>
<td>35</td>
<td>100</td>
</tr>
</tbody>
</table>
Participant POD: POD is a 76 year old male diagnosed with non-fluent aphasia post-CVA. POD presented with a right-sided hemiplegia. He is taking medication for high blood pressure and diabetes, as well as olanzapine for undisclosed reasons. Significant findings from POD’s case history included a heart attack in 2003, and hearing difficulties, with increased difficulty reported on his right ear (present prior to his CVA). The researchers compensated for POD’s hearing difficulty during the treatment phase by increasing the proximity between the researcher and POD’s less impaired ear and increasing the volume of the spoken target words. During initial assessment, POD could follow instructions and repeat spoken words during the CAT Real Word Repetition subtest, and was therefore considered a candidate for this study. POD’s language profile is as follows: On the CAT, POD scored 21/30 on the Comprehension of Spoken Words subtest, and 26/32 on the Real Word Repetition subtest. The repetition subtest was administered twice, where assessors compensated for POD’s hearing deficit by administering the compensatory strategies listed above on the second trial. Results from the second trial were accepted. POD scored 15/60 on the BNT, with errors characterized as semantic (25) and perceptual (6). Providing a phonological cue did not aid POD’s word retrieval for any of the target items. On the multiple-choice component of the BNT, POD got 23/45 correct, often selecting the semantic distractor. Based on these results, POD is diagnosed with anomia characterized by impairment at the level of the semantic lexicon.

Materials
A total of 600 words representing nouns were used (500 treated, 100 control). The items chosen were selected and used by Kelly (unpublished). Kelly indicates that the 600 words used in this study have at least an 80% naming agreement, and are balanced for syllable-length and frequency. Naming agreement was obtained from 22 normal controls on two separate occasions. All 22 participants returned fully completed naming sheets for the 680 items. From this cohort, a total of 600 items with at least 80% name agreement were selected for this study. Frequency ratings were obtained from the CELEX database (Baayen et al 1995). The mean log frequency for the selected words was calculated as 2.63 (SD 0.70, range 0.48-4.17). The mean syllable length was 1.72 (SD 0.74, range 1-4). Colour images from the Internet were randomly arranged in slideshow format within their designated
treatment set described below. Arrows were provided in pictures where the target word was difficult to depict.

Therapy Sets
The 500 treatment items were divided into 5 sets, where a different set of 100 words was treated each week. Each treatment set (5x n=100), and the control set (n=100), were balanced for frequency and syllable-length (Franklin 1997) by matching the individualized therapy and control sets for log frequency, syllable length and baseline naming ability. No set was significantly different for any of these variables (Franklin 1997; Kelly unpublished). Details of the matching data for each set, retrieved from Kelly (unpublished) are provided in the appendix. Note that Kelly’s study involved dividing the 500 words into 12 sets of 50. The present study combined two of these sets to form one set, amounting to 6 sets of 100 words.

Each participant was assigned a different treatment set each week, to ensure that differences arising between treatment sets (such as those indicative of primacy or recency effects) are not due to the particular words in each set. Table 3 presents the treatment sets used each week for each client.

<table>
<thead>
<tr>
<th>Table 3. Treatment Sets Assigned to Each Participant per Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
</tr>
<tr>
<td>JM</td>
</tr>
<tr>
<td>MOB</td>
</tr>
<tr>
<td>GB</td>
</tr>
<tr>
<td>POD</td>
</tr>
<tr>
<td>AB</td>
</tr>
</tbody>
</table>

Treatment Protocol
Two treatment sessions occurred every week for five weeks. Treatment involved 2 repetitions per session, amounting to 4 facilitations of each target word.

Pictures were presented alongside a spoken model of the target word, which the participant was requested to repeat. This represents an errorless learning approach, which is used in order to avoid production errors during training (Fillingham et al 2006). Every time a response is produced, whether correct or in error, a facilitation effect occurs, which
strengthens the neurological connections between the target word’s phonological and semantic lexicon (Howard et al 2006; Fillingham et al 2006). Erroneous responses must be minimized in order to investigate the underlying mechanism of facilitation for the treated items.

The participants were not provided with any words or pictures to practice on their own time. Therapy sessions took place in the participant’s homes, with exception to POD, where two sessions including post-treatment assessment took place in a hospital setting.

**Results**

**Group Analysis**

The pre and post-treatment results for each participant are provided in Table 4. Pre and post treatment mean percentile scores for treated (n=500) and untreated (n=100; BNT n=35; PALPA n=15) sets are presented in Figure 1. The group mean improved by 10% from pre-treatment to post-treatment for the n=500 treated set, and remained relatively stable for untreated sets, with a larger increase evident on the PALPA. The n=100 set increased by 0.4%; the BNT decreased by 0.56%; the PALPA: increased by 8%.

<table>
<thead>
<tr>
<th>Table 4. Pre and Post-Treatment Results for each Participant, Including Post Treatment Outcomes for each Treatment Set (5x n=100) Relative to Week Treated (raw data).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant:</td>
</tr>
<tr>
<td>Treated Set (/500)</td>
</tr>
<tr>
<td>109</td>
</tr>
<tr>
<td>Untreated Set (/100)</td>
</tr>
<tr>
<td>Treated BNT (/25)</td>
</tr>
<tr>
<td>Untreated BNT (/35)</td>
</tr>
<tr>
<td>Untreated PALPA (/20)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Post-Treatment Outcomes for n=500 Treated Set Relative to Week Treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
</tr>
<tr>
<td>Week 2</td>
</tr>
<tr>
<td>Week 3</td>
</tr>
<tr>
<td>Week 4</td>
</tr>
<tr>
<td>Week 5</td>
</tr>
</tbody>
</table>
Paired sample T-tests were used to analyze the group results as this data was not normally distributed (skewness= -0.730; kurtosis= -2.158), which indicate no significant difference for treated items between pre treatment (M=34.4, SD=18.25) and post treatment (M=44, SD=18.47); t(4)=2.154, p=0.098). Large SD indicates variation amongst participant’s naming abilities at pre and post treatment. Paired Sample T-tests also indicate no significant differences between pre and post-treatment mean percentile scores for the n=100 untreated set (Pre treatment: M= 39, SD= 20.17; Post treatment: M=39.4, SD=21.52); t(4)=0.073, p=0.945), BNT untreated set (Pre treatment: M=19.42, SD=6.55; Post treatment: M=18.86, SD=7.48); t(4)=10.77, p=0.886), and PALPA untreated set (Pre treatment: M=52, SD=19.91; Post treatment: M=60, SD =12.15); t(4)=9.33, p=0.269).

Different pictures representing the same target words used in the n=500 treated set were provided in the BNT. Pre and post treatment scores for treated items in the BNT (n=25) were analyzed using paired sample T-tests. Figure 2 illustrates the mean percentiles at pre and post treatment for the BNT treated set, which improved by 9.4%. Paired sample T-tests indicate no significant difference between treated items on the BNT from pre-treatment (M=40.8, SD=16.35) to post-treatment (M=50.4, SD=15.9); t(4)=5.55, p=0.153. This is unsurprising, since improvements for the n=500 treated set are not significant.

![Figure 1: Mean percentile scores of the Group results for the n=500 treated set; n=100 untreated set; BNT untreated set; PALPA untreated set.](image-url)
Conclusion
Numbers increased for treated items, though variation amongst participant’s naming abilities as well as our small sample size may have hindered attainment of significance. The following section presents the results for two participants included in this study, in an attempt account for this variation. Primacy and recency effects were analyzed at the individual level.

Individual Case Results- POD
POD improved his naming by 40 items on the n=500 treated set, and did not improve on the n=100 untreated set from pre to post treatment (Figure 3). POD’s results for the additional untreated items on the BNT and PALPA remained relatively stable (BNT: decrease by 4 items correct; PALPA: decrease by 1 item correct) (Figure 4). McNemar Tests indicated a significant change between pre and post treatment scores for the n=500 treated set (p=0.014) and no significant change between pre and post scores for the untreated items from the n=100 set (p=0.678), BNT (p=0.289) and PALPA (p=1.0). This indicates that Facilitation Therapy significantly improved POD’s word finding for the treated items.

POD increased his naming accuracy by 5 items on the BNT treated set (Figure 5). McNemar Tests indicate that this improvement is not significant (p=0.125). This result is unlike that of the 500-treated items, which improved significantly.
Figure 3. POD’s percentile scores for the n=500 treated set and n=100 untreated set. Statistically significant improvement evident for the treated set at post-treatment. No improvement evident for the untreated set.

Figure 4: POD’s Pre and Post treatment scores for the BNT untreated set and the PALPA untreated set (raw data)

Figure 5. POD’s Pre and post treatment scores for the BNT treated set (n=25); Improvements were not significant.
Further analysis of POD’s errors on the BNT treated set indicated that these items are harder for POD. Of 13 erroneous responses made on the BNT treated set, 10 were also in error on the n=500 treated set. Therefore, the limited gain evident on the BNT treated set is reasonable. Items that generated a discrepancy between post-treatment sets may represent perceptual error. “Bench” was scored as correct at both pre and post treatment on the n=500 treated set, and as incorrect at pre and post treatment on the BNT treated set, where he responded in error on both occasions with “seat”. “Tongs” was scored as incorrect on both sets at pretreatment, incorrect on the BNT treated set, and correct on the n=500 treated set at post-treatment. These errors were classified as a non-response.

Figure 6 presents POD’s pre and post treatment scores for the n=500 treated set, relative to week treated. Chi square tests were administered in order to compare performances for the five different treatment times. No statistically significant results were found at post-treatment between weeks treated (p<0.05), indicating an absence of primacy and/or recency effects.

![Figure 6. Post-treatment outcome scores for treated items, relative to week treated.](image)

**Individual Case Results- AB**

During treatment, AB presented with clinical signs of apraxia (groping, phonological distortions, difficulty repeating stimuli) that varied in severity between sessions. This variation may explain AB’s adequate score on the real-word repetition subtest despite occasional repetition difficulties during the treatment phase, where she was not able to accurately repeat a number of target stimuli. In order to maintain consistency, AB was
provided one attempt at naming before moving on to the next picture stimuli, meaning that she repeated a small proportion of target words in error.

Figure 7 illustrates that AB increased her naming accuracy on the n=500 treated set by 133 items. She also increased her naming accuracy on the n=100 untreated set by 22 items. McNemar Tests indicate a significant change between pre and post treatment for the n=500 treated set (p<0.01), and, unexpectedly, the n=100 untreated set (p<0.01). Figure 8 illustrates AB’s smaller gains on the additional untreated items, where AB’s naming accuracy increased by 3 items on the BNT and 1 item on the PALPA. McNemar tests indicate that these changes were not significant (BNT: p=0.25; PALPA: p=1.0). Figure 9 illustrates AB’s improvement on the BNT treated set, where her naming accuracy increased by 6. McNemar Tests indicate that this change is significant (p=0.031). Although AB significantly improved her naming ability at post–treatment on both the n=500 treated set and the BNT treated set, generalization to the n=100 untreated set implies that gains cannot be directly attributable to facilitation.

Figure 7. AB’s percentile scores for the n=500 treated and n=100 untreated set at pre and post-treatment
The nature of AB’s erroneous responses on the BNT (n=60) were compared between pre and post-treatment. Analysis using raw data showed a 10% decrease in the production of phonological paraphasias and neologisms from pre to post treatment, whereby there was a 4% increase in the production of semantic errors (Table 5). Thus, treatment seemingly helped remediate AB’s phonological-type errors.

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Pre Tx</th>
<th>Post Tx</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Phonological &amp; Neologisms</td>
<td>17/28%</td>
<td>11/28%</td>
<td>10% decrease</td>
</tr>
<tr>
<td>Semantic</td>
<td>4/9%</td>
<td>5/13%</td>
<td>4% increase</td>
</tr>
</tbody>
</table>
Chi square tests were administered to compare AB’s results relative to week treated. No statistically significant differences between the first and last week’s treatment sets were found at post-treatment (p>0.05), indicating no primacy or recency effects.

![AB's pre-and post-treatment scores for n=500 treated set relative to week treated](image)

**Figure 1.** AB’s pre-and post-treatment scores for n=500 treated set relative to week treated

**Conclusion**

Numbers improved for the group, but large variation amongst the participant’s abilities and small sample size may have hindered attainment of significance. Statistical analysis of POD and AB’s results did not reveal primacy or recency effects, indicating that their improvements are not attributable to the recruitment of episodic memory. Facilitation therapy significantly improved POD’s word retrieval for treated words and gains did not generalize, indicating that his improved naming accuracy is attributable to a facilitation effect. AB’s results were more striking, as they allude to the involvement of naming facilitation in addition to another mechanism that facilitated generalization to the untreated set. AB’s repetition difficulties that are characteristic of Apraxia of Speech (AOS) may indicate that this therapy approach also targeted AB’s motor speech, resulting in improved naming accuracy.

**Discussion**

**Group Analysis**

The group results approached, but did not reach significance, indicating that improvements using facilitation therapy may be limited to a certain cohort of individuals with anomia.
Considering a statement by Snell et al (2010), “participants post CVA, regardless of severity, are able to learn large numbers of words when given the opportunity”. If the word “opportunity” translates to time, then perhaps our participants required more time, or facilitations of each target word, in order to increase improvement. On the other hand, if “opportunity” translates to the treatment approach, then perhaps some of our participants did not tolerate errorless learning.

**Errorless Learning**

We used an errorless learning approach in order to avoid production errors that can be self-reinforcing during training. This contrasts with traditional approaches where participants’ errorful responses are corrected by the therapist, and guessing is advocated in the belief that this will encourage better performance (O’Carroll et al 1999). An example of errorful learning, explained by Fillingham et al (2005), is when the subject is requested to name a picture, and, if incorrect, is provided with progressive phonemic and/or orthographic cueing. In Fillingham et al’s study, they compared errorless and errorful learning using a case series with 11 people with anomia, and found no difference in the effectiveness of both therapy approaches for anomia remediation. However, one participant was noted to benefit more from errorful therapy immediately and in the long term. Fillingham et al (2003) noted that errorless learning is inherently monotonous and might suffer from being a passive treatment, and Friedman (2004) suggests that training improvements are amplified when effort is introduced. With consideration to the above, errorless learning carries several implications that may not suit a particular individual with anomia.

Nonetheless, errorless learning was required for this study, as we were investigating the integrity of the facilitation effect for the treatment of a large number of words. Therefore, erroneous responses needed to be minimized.

**Individual Analysis- POD**

Treatment was successful for POD, and the absence of both generalization and primacy and/or recency effects indicate that his improved naming is directly attributable to facilitation. However, this improvement did not transfer to treated items on the BNT. We
propose two explanations that account for this discrepancy: the first accounts for the small proportion of words that were retrieved on the n=500 treated set but not the BNT treated set; the second accounts for the larger proportion of words that were consistently incorrect across both treated sets.

POD’s errors on the BNT for ‘bench’ and ‘tongs’ may be due to the quality of the BNT’s picture stimuli, resulting in a perceptual, rather than semantic error. The BNT stimuli are relatively smaller black and white drawings, whereas the n=500 treated set stimuli are larger and in colour. Therefore, it is reasonable to suggest that POD failed to name these items on the BNT as a result of incorrect visual-perceptual comprehension of the picture stimulus, which precedes the processes of accessing a word’s lexical form (Baldo et al 2013). As a result, POD retrieved the lexical form for “seat” based on his visual-perceptual comprehension. It is likely that POD did not attempt to access the lexical form for “bench” and therefore, his elicitation of “seat” was not due to semantic error; that is, confusion arising in the process of choosing between these words with common elements of meaning (Nozari et al 2010). POD’s ability to accurately produce ‘tongs’ and ‘bench’ on the n=500 treated set indicates that facilitation was effective for activating these words above threshold, and it is likely that POD would have been able to retrieve these words had he accurately perceived the stimulus cue. In summary, POD’s errors on the BNT treated set are more likely perceptual rather than linguistic in nature, which may be due to the quality of pictures on the BNT.

The second explanation is that the treated items included in the BNT were harder items to learn and retrieve, which may be due to their characteristic frequency. Frequency effects are attributed to faster facilitation in both normal subjects (Bonin et al 2004) and aphasic subjects (Nickels and Howard 1994) because their resting potential is closer to threshold than less frequent words. The consistent errors across treated sets indicate that facilitation for a large number of words favours remediation of items that are closer to threshold; ie., high frequency words. Since the majority of words in error on the BNT treated set were also in error on the n=500 treated set, it is likely that these items are low frequency words, and require a larger number of facilitations in order to facilitate activation at threshold and their subsequent retrieval.
POD’s results did not indicate recruitment of the episodic memory, and therefore we can infer that gains made are attributable to facilitated strengthening of the connections between semantic and phonological domains for each treated item. With consideration to POD’s semantic impairment, presentation of the picture was essential to facilitate access to the target word’s semantic lexicon; otherwise, POD may have accessed his phonological output lexicon directly from the phonological input lexicon for the target word, passing the semantic lexicon and thereby preventing facilitation of his most impaired domain. Thus, inclusion of each target word’s picture was likely fundamental to POD’s significant improvement.

**Individual Analysis- AB**

Generalization to the n=100 untreated set was not expected, and cannot be attributed to facilitation alone. Therefore, we suggest that AB’s generalization occurred because treatment also targeted AB’s speech difficulties.

With consideration to principles of neuroplasticity, the repetitive nature of our therapy approach may have resulted in generalized improvements to AB’s motor speech, as well as a reduced number of phonological paraphasias and neologisms on the BNT at post-treatment. Research shows that rehabilitation efforts produce physiologic cortical reorganization (Crosson et al 2007; Meinzer and Breitenstein 2008). Papathanasious (2013) indicates that principles such as “use it or lose it” may be extremely important considerations in the treatment of motor speech disorders such as in AOS. The principles of “repetition matters” and “intensity matters” have been demonstrated to be important factors in the behavioural motor learning literature. Moreover, treatment for AOS involves following principles of motor learning to reestablish underlying programs, and the role of mirror neurons suggests that watch and listen/ imitation therapies will assist (re)acquisition. Repeated, motoric practice has been included as an important aspect of almost all articulatory-kinematic treatments, and repetition is likely to be one of the most potent treatment factors for facilitating neuroplasticity for motor speech (Papathanasiou 2013).

AB’s generalization begs the question: did neuro-plasticity have any role in the remediation of linguistic functions for AB? AOS rarely appears in pure form, and AB presented with comorbid signs of apraxia and anomia. The manifestation of facilitation is evident through
her significant improvement on the treated BNT items. However, AB’s lack of generalization to untreated BNT items may have been primarily affected by her linguistic deficit. Thus, consolidated focus on both AB’s motor speech and language abilities may have maximized improvements for the treated sets, more so than if only speech was targeted. Unfortunately, the nature of this current study does not enable identification of the extent to which therapy targeted speech production relative to facilitation. However, AB’s results may indicate that therapy for individuals with comorbid AOS and anomia should include increased emphasis on linguistic functions as well as motor speech. Facilitation therapy through a repetition approach may maximize improvements for individuals with AOS by targeting their motor speech and linguistic deficits.

**Recommendations**

Therapy followed an errorless learning approach, however this therapy involved the picture being presented first followed by the stimulus cue. This is not a true form of errorless learning as prior to hearing the phonological form, the individual may access his or her own lexical form based on semantic error or an alternative interpretation of the picture, which may compromise the integrity of facilitation for the target word. In individuals with intact auditory comprehension, errorless learning should involve a spoken elicitation of the target word, followed by its picture.

The 500 treatment words were selected before meeting the participants. In order to maximize functionality, clinician’s must choose words that are functional for the client. Understandably, it may not be practical to ask a client or their caregivers to select 500 words. We suggest that clinicians prepare a standard list of 400-450 medium to high frequency words, and have the client and/or caregivers select 50-100 functional and more personalized treatment words.

We did not obtain participant’s medical and/or speech and language therapy history; we did not perform speech and language diagnostic assessments; and we did not obtain neurological imaging prior to our study. This would have been beneficial given the extensive variability of the group results, as well as provided greater indication as to the characteristics of anomia that correlate with an increased facilitation effect.
Our current therapy design does not assess generalization to conversation. Future research should assess transference of gains made at word-level to conversational speech for the treatment of a large number of words. Also, due to time limitations, maintenance of therapy gains was not assessed. A follow up study for the treatment of a large number of words for the participant’s that showed significant improvement is warranted.

**Acknowledgements**

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References


Kelly, K. (unpublished) ‘Naming facilitation therapy: How many words can be learned this way?’.


Papathanasiou, I., Coppens, P. and Potagas, C. *Aphasia and Related Neurogenic Communication Disorders*, Burlington, MA: Jones & Bartlett Learning


## Appendix

### Matching Data for Treatment Sets (Retrieved from Kelly (unpublished))

1. Standard Deviation  2. Expressed as % of Total

<table>
<thead>
<tr>
<th>Treatment Set (Kelly’s study)</th>
<th>Treatment Set (Present study)</th>
<th>Mean No. of Syllables (SD) ¹</th>
<th>Mean Log Frequency (SD) ¹</th>
<th>Baseline Naming Ability (%) ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small set (n=50)</td>
<td>Untreated items (n=100)</td>
<td>1.78 (.78)</td>
<td>2.54 (.77)</td>
<td>14 (28%)</td>
</tr>
<tr>
<td>Control set (n= 50)</td>
<td></td>
<td>1.66 (.82)</td>
<td>2.74 (.64)</td>
<td>14 (28%)</td>
</tr>
<tr>
<td>Large Set (n=500)</td>
<td>Treatment Set (n=500)</td>
<td>1.72 (.73)</td>
<td>2.63 (.70)</td>
<td>146 (29.2%)</td>
</tr>
<tr>
<td>Large Set 1 (n= 50)</td>
<td>Treatment Set 1 (n=100)</td>
<td>1.74 (.74)</td>
<td>2.56 (.76)</td>
<td>14 (28%)</td>
</tr>
<tr>
<td>Large Set 2 (n= 50)</td>
<td>Treatment Set 2 (n=100)</td>
<td>1.86 (.85)</td>
<td>2.58 (.73)</td>
<td>14 (28%)</td>
</tr>
<tr>
<td>Large Set 3 (n= 50)</td>
<td>Treatment Set 3 (n=100)</td>
<td>1.78 (.73)</td>
<td>2.60 (.72)</td>
<td>14 (28%)</td>
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<tr>
<td>Large Set 4 (n= 50)</td>
<td>Treatment Set 4 (n=100)</td>
<td>1.76 (.84)</td>
<td>2.61 (.69)</td>
<td>14 (28%)</td>
</tr>
<tr>
<td>Large Set 5 (n= 50)</td>
<td>Treatment Set 5 (n=100)</td>
<td>1.62 (.72)</td>
<td>2.62 (.68)</td>
<td>15 (30%)</td>
</tr>
<tr>
<td>Large Set 6 (n= 50)</td>
<td>Treatment Set 6 (n=100)</td>
<td>1.64 (.66)</td>
<td>2.64 (.67)</td>
<td>15 (30%)</td>
</tr>
<tr>
<td>Large Set 7 (n= 50)</td>
<td>Treatment Set 7 (n=100)</td>
<td>1.86 (.72)</td>
<td>2.65 (.67)</td>
<td>15 (30%)</td>
</tr>
<tr>
<td>Large Set 8 (n= 50)</td>
<td>Treatment Set 8 (n=100)</td>
<td>1.56 (.64)</td>
<td>2.66 (.67)</td>
<td>15 (30%)</td>
</tr>
<tr>
<td>Large Set 9 (n= 50)</td>
<td>Treatment Set 9 (n=100)</td>
<td>1.58 (.70)</td>
<td>2.69 (.68)</td>
<td>15 (30%)</td>
</tr>
<tr>
<td>Large Set 10 (n= 50)</td>
<td>Treatment Set 10 (n=100)</td>
<td>1.78 (.64)</td>
<td>2.68 (.68)</td>
<td>15 (30%)</td>
</tr>
</tbody>
</table>