

## **Critical Review:**

### **The effectiveness of errorless learning in the treatment of word finding difficulties for persons with aphasia**

Angle, K.

M.Cl.Sc. (SLP) Candidate

School of Communication Sciences and Disorders, UWO

This critical review examines the effectiveness of errorless (versus errorful) learning in the treatment of word finding difficulties for persons with aphasia. One review of the aphasia literature and three studies using a single-subject design were analyzed to determine the clinical effectiveness of using errorless learning as a therapeutic technique in the treatment of word finding difficulties. The results suggest that errorless and errorful learning are equally effective.

#### ***Introduction***

Our ability to function effectively in the world is highly dependent on language. Therefore, an acquired language deficit can be extremely debilitating and distressing for both the patient and those people around them (Fillingham et al., 2006). Aphasia is defined as “an acquired communication disorder caused by brain damage, characterized by an impairment of language modalities: speaking, listening, reading and writing; it is not the result of a sensory deficit, a general intellectual deficit or a psychiatric disorder” (Chapey & Hallowell, 2001, pp. 3). The term anomia is used to describe word-finding difficulties, which is perhaps one of the most common and disabling symptoms found in cases of aphasia (Fillingham et al., 2003). There are many examples of therapies in the literature that are aimed at treating word-finding difficulties. While various types of therapies exist, traditionally the method of therapeutic intervention has involved a trial and error approach wherein the patient’s errorful responses are corrected by the therapist and guessing is advocated in the belief that this will encourage better performance (Fillingham et al., 2005b). Recently, there has been much interest in errorless learning as a new intervention technique (Fillingham, et al., 2003).

#### *What is errorless learning?*

Neural plasticity refers to the ability of the brain to change its functions. Research in neuroscience has shown that the mature brain is capable of ‘rewiring’ itself so that new functions can be learnt by brain areas that previously performed other processes (Fillingham et al., 2003). In neuroscience, it is a fundamental notion that synaptic efficiency is a substrate for learning and memory (Buonomano & Merzenich, 1998 as cited in Fillingham et al., 2003). If an input elicits a particular pattern of neural activity, Hebbian learning will strengthen the tendency to activate the same pattern on subsequent occasions, increasing the likelihood of making the same response in the future, regardless of whether it is correct or incorrect (Fillingham et al., 2006). These basic ideas have been that basis for applied research which suggests errorless

learning in intervention may show benefits over traditional trial and error methods (Fillingham et al., 2006). The key notion underpinning errorless learning is that in some situations, errors can be self-reinforcing, and remediation is enhanced if participants are prevented from reinforcing their own errors (Fillingham et al., 2003). Evidence from studies in the amnesia literature suggests the possibility that errorless learning may be a technique that could be used to treat word-finding difficulties in patients with aphasia (Fillingham et al., 2003).

#### ***Objective***

The objective of this review is to critically examine the evidence that errorless learning is an effective approach to the treatment of word finding difficulties in persons with aphasia? Recommendations regarding the use of errorless learning as an intervention technique will be made based on the literature reviewed.

#### ***Methods***

##### **Search Strategy**

Computerized databases, including CINAHL, PubMed and Medline were searched using the following search strategy:

(aphasia) AND (errorless learning ) AND (anomia) or (word finding)

The search was limited to articles written in English between 1980 and 2006.

##### **Selection Criteria**

Studies that were included in this critical review paper were required to examine the effectiveness of errorless learning compared to errorful learning as an intervention technique used for patients with aphasia with word finding difficulties.

##### **Data Collection**

Results of the literature search yielded one review of the literature and three case series analyses (i.e. a

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single-subject design with multiple participants) with multiple baselines.

### *Results*

Fillingham et al. (2003) is a review of 28 studies found in the aphasia and amnesia literature concerning errorless and errorful learning in the treatment of anomia. They found that most of the studies used errorful techniques. However, they were able to review a reasonable number of error reducing studies. They results of the comparisons were reported in terms of the proportion of interventions that showed effects by therapy type, principle impairment and patient type for each of their three efficacy measures. The authors suggested that while the number of studies prevented any formal statistical analysis, the review found evidence to suggest errorless approaches are just as likely to achieve a positive effect on word finding difficulties (in terms of immediate effect, at follow up and in terms of generalization). There was no information available to suggest that error reducing techniques are superior to errorful learning approaches.

The (2006) study by Fillingham et al. describes a case series analysis with multiple baselines for 11 participants with aphasia comparing errorless and errorful approaches in the treatment of word finding difficulties measured in terms of naming accuracy. The results were analyzed using one- and two-tailed McNemar's tests. The overall results from this study suggest that errorless and errorful therapies are equally likely to be effective for patients who respond to therapy. It is still not absolutely clear which therapy is best for a specific patient but there is some suggestion that patients who had good attention and recall memory will likely exhibit slightly better long-term improvements. The patient's language status did not predict therapy outcome but instead the authors found that improvements in naming, regardless of therapy type, were related to the patient's recognition memory, frontal/executive skills and monitoring ability.

The 2005(b) study by Fillingham et al. used a crossover case series design with multiple baselines for 7 participants with aphasia comparing errorless and errorful approaches, when feedback is removed, in the treatment of word finding difficulties measured in terms of naming accuracy. The results were analyzed using one- and two-tailed McNemar's tests. Errorless and errorful learning therapy produced equivalent results immediately post-treatment and at follow-up assessment and neither approach show any generalized effects. There was no effect seen of omitting feedback. The participants learned equally as well without feedback regarding the accuracy of their responses. In this study immediate naming effects, regardless of therapy type, were related to the participant's non-

linguistic, executive skills rather than their language status and overall participants who responded best had better executive/problem-solving skills and better monitoring ability.

The 2005(a) study by Fillingham et al. also describes a crossover case series analysis with multiple baselines for 7 participants with aphasia comparing errorless and errorful approaches in the treatment of word finding difficulties measured in terms of naming accuracy. Feedback was removed again and the number of naming attempts was increased. The results were analyzed using one- and two-tailed McNemar's tests. This study replicated the finding of the two previous studies – equivalent results were seen immediately post-treatment and at follow-up assessment. Similarly, participants who responded well to both treatments were those with better monitoring skills, recall and recognition memory and executive/problem-solving skills.

### *Discussion*

#### **Purpose and Design**

Fillingham et al. completed three studies comparing errorless and errorful learning to treat word-finding difficulties for persons with aphasia (2006, 2005 a, 2005 b). The (2006) study was designed for five purposes: to test if errorless learning is an effective learning technique for word finding difficulties in persons with aphasia, to compare errorless and errorful approaches directly, to measure immediate and long term effects and generalization, to identify the aspects of patients language and cognitive skills that predict an effect of each therapy and to measure accuracy during therapy to compare the error rates between the two techniques. A case-series analysis with multiple baselines was used. A case series is a type of single-subject design involving a multiple subjects (Hedge, 1994). Single subject designs are concerned with the behaviour of individuals under different conditions as opposed to comparisons between groups of people. Therefore, this type of design is appropriate given that the authors are interested in measuring the naming accuracy for each of the subjects for each of the techniques. It is also an advantageous study design in that no one is denied treatment for control purposes.

Their second study (2005b) was designed to test if (a) errorless learning therapy becomes superior to errorful therapy if feedback is removed, and (b) to replicate the finding that non-language status predicts therapy outcome. In this paper, a multiple baseline, crossover case series design was used. The third study (2005a) had four aims: to replicate their previous findings that errorless learning is as effective as errorful learning (without feedback and with an increase in the number of naming attempts), to identify which aspects

of the participants language and cognitive skills predict therapy outcome, to compare error rates for each technique, and to explore the effect of self-generated versus examiner generated responses by looking at error rates during each treatment. Again, a multiple baseline, crossover case series design was used.

In latter two studies a case series design is again appropriate given that the examiners are comparing accuracy and error rates for each type of therapy. The authors introduced crossover, (i.e., the counterbalancing of the two treatments within the sessions) in the last two studies, in order to control for an effect of the order of treatment. By adding this additional level of control, they strengthened the design of the last two studies.

A strength of these three studies is that they use multiple baselines to determine naming accuracy before treatment. Baselines are an important control strategy in single-subject designs (Hedge, 1994). The absence of treatment in the baseline condition makes it the control condition against which the treatment conditions can then be compared. However, baselines should meet certain criteria to be considered adequate to evaluate treatment effects. According to Hedge (1994), these criteria include: reliability through multiple observations, stability of measurement and the potential for contrast. The first criterion is as such because a single measurement is not adequate to be considered reliable. Reliability, by definition, is consistency across measures and so multiple measures are needed to be sure the frequency with which the dependent variable naturally occurs has been documented. The authors do indicate that three measures were taken in order to establish a baseline in each of these studies. Depending on your definition of multiple, this criterion has been satisfied. However, measuring naming accuracy a few more times would strengthen the procedure in these studies. The second criteria, stability of measures is very important because a highly variable baseline does not allow for a valid comparison of responses under the treatment condition. The authors report that they included three measures in order to establish a stable baseline (using the highest of the 3 for comparison) but they do not report any data so the readers themselves can evaluate stability or trends in the baseline measures. Inclusion of this data would add to the quality of the studies. Finally, baselines need to have the potential for contrast, that is, they should have either a very high or a very low response level so that decreases or increases in response level in the treatment condition can clearly be considered effects of treatment. Visual inspection of the tables in the studies indicates that the baselines are sufficiently low enough to consider any change to be the result of treatment.

### Subject Selection

There were numerous criteria that had to be met before a study was included in the Fillingham et al. (2003) review. After applying the inclusion criteria, the authors selected one (out of eleven) study from the amnesia literature and 27 (out of 52) studies from the aphasia literature. The selection criteria used for this review seem to be designed with the method for future empirical studies in mind. The review includes a sufficient number of studies to draw conclusions about the available evidence regarding the effectiveness of errorless learning in treating word-finding difficulties in persons with aphasia.

The first study by Fillingham et al. (2006) included 11 subjects, recruited from local SLP services, primarily on the basis that they had word-finding difficulties due to some central language impairment. The subsequent studies (2005b, 2005a) each included 7 subjects, all of whom participated in this first study. Patients were all at least 6-months post-onset, had acquired neurological deficits, had a significant word-finding problem and could repeat or read with a degree of accuracy. Patients with perceptual deficits, dyspraxia or speech-motor programming deficits were excluded. By excluding these patients, the authors did control for the influence of other deficits not related to language on the participant's performance. In single-subject designs, subjects are not selected randomly (Hedge, 1994). Given the nature of the research, sufficient care was taken to include like subjects. The authors also explain their reasons for choosing the subjects this way. In order to investigate the utility of errorless in a variety of patients with aphasia, limited selection criteria were used. Finally, the authors also included an extensive battery of language and neuropsychological assessments because they wanted to look for correlations between language and executive skills and the therapy techniques. This necessitated that patients who ranged in severity, and had a range of deficits, be included.

### Method

The studies in the Fillingham et al. (2003) review were categorized as errorless (specifically error eliminating or error reducing) or errorful. The merits of each approach were considered in terms of three efficacy measures: improvement immediately after therapy, residual benefit after a period of no therapy and generalization to untreated items. Operational definitions of error reducing, error eliminating and errorful learning were provided, so the comparisons being made are clear. This method was judged to be appropriate given the author's purpose for the review.

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As no effort is made to have a representative sample the conclusions of the studies that follow can not be extended to the general population. Generality in single-subject designs is a matter of replication (Hedge, 1994). In all three studies (Fillingham et al., 2006, 2005b, 2005a), the method is laid out well enough such that other authors could replicate the procedure. The timelines and assessment measures are clearly stated and the therapy procedures and instructions are outlined for the reader. In the first study, assessments were carried out immediately after therapy to assess immediate effect on the treated and untreated items, as well as generalization to the control set of items. A criticism of the (2006) study is in the way that they present these data. Although they measured the accuracy for treated and untreated items, they do not provide these numbers for comparison. Because they want to determine the effectiveness of therapy, the reader should be able to clearly see that increases are the result of the particular treatment rather than due to the fact that therapy of any kind was being provided. This is not an issue in the second and third studies (2005b, 2005a) because the two therapies were carried out in the same session and the effects were clearer.

### Measurement Tools and Outcome

In all three studies (Fillingham et al., 2006, 2005b, 2005a) the authors recorded the number of correct responses before treatment and after 10 sessions using each technique to measure naming improvement. The authors provide their rationale for choosing to measure naming this way. They explain that they chose to measure naming by monitoring the participants overall responses during each session rather than giving a naming assessment because they did not want to contaminate errorless therapy by possibly introducing errors in the naming assessment. Given this reason this seems like a reasonable way to measure naming.

### Statistical Analysis

The data in the Fillingham et al. (2003) review could be considered nominal in that they were simply trying to determine whether or not there was an effect of treatment. In terms of the statistical analysis, they looked at the total number of interventions included in the 28 studies and report the proportion of interventions that show effects by therapy type, principle impairment and patient type for each of the three efficacy measures. This seems to be an appropriate way to compare the studies considering their purpose.

In all three studies (Fillingham et al., 2006, 2005b, 2005a) the authors used one- and two-tailed McNemar tests to test for significant changes in the number of items named in each treatment condition.

According to Green et al. (2000), McNemar's test is used for comparisons within measures when there is one factor or independent variable with two categories, groups, levels or samples. In all three studies there is a single independent variable, specifically naming, that is being measured and compared at two different times. McNemar's test, therefore, seems to be an appropriate choice. It is also appropriate given that the data being compared are counts rather than measures of central tendency or ranks. Specifically, they used the one-tailed test to test for significant increases in the number of named items between baseline and post-treatment and to detect the long-term effect, comparing baseline measures and follow-up measures. They used the two-tailed test to test for significant increases in the number of items retained, i.e. post-treatment to follow-up. The authors do not provide a rationale for why they chose to use a one-tailed test when they did. The reader can only assume that they only considered possible increases in naming where a one-tailed test is used. The analysis would be improved by using a two-tailed test in all cases.

For participants who showed an effect of therapy, chi-squared was used to determine which therapy was more effective, in the first study only. This test seems to fit with the description of chi-squared given by Green et al. (2000). Specifically chi-squared is used when making a comparison between groups in situations where there is one factor or independent variable with 2 categories, levels, groups or samples. The significance levels that they report for all of their statistics are  $p=.05$  or less which gives the reader confidence in their findings.

Finally, a t-test was used in all three studies to test for differences in error rates between the two therapies. It is not clearly stated and so it can only be assumed that they grouped the data for each participant to make these comparisons. This is not directly related to the evidence based question but is worth noting because it relates to the procedure for the therapies. The authors were attempting to monitor the error rates to determine if it is possible to completely remove all errors in therapy.

### Recommendations

The results of studies in the rehabilitation literature with patients with amnesia indicate that errorless learning should produce superior results compared to errorful learning in the relearning of names. The results of the Fillingham et al. review (2003) and the three empirical studies that followed (2006, 2005b, 2005a) suggest that errorless and errorful techniques for word-finding difficulties provided equivalent results for most of these participants with aphasia. It is important to note that since no effort is made to have a representative sample in single subject

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designs the conclusions of the study can not be extended to the general population (Hedge, 1994). The critical review does suggest ways that the studies could be strengthened however; these three studies provide moderate evidence regarding the effects of errorless learning. Based on this evidence, and given that the participants in these studies indicated that they preferred errorless learning because it was less frustrating and more rewarding, I would recommend the use of errorless learning techniques in clinical practice. However, before initiating either type of therapy I would recommend gauging the patient's potential to respond based on an assessment of their executive/problem solving skills, their recall and recognition memory and their ability to monitor their own performance as these factors we shown to predict therapy outcome.

### Conclusions

Errorless learning as a therapeutic technique for the treatment of word finding difficulties for persons with aphasia has been shown to be as effective as the more traditional errorful techniques. It can be used effectively in clinical practice however, clinicians must first consider the patient's non-linguistic executive skills, recall ability and ability to self monitor before engaging in errorless learning as these were found to be predictors of success in therapy.

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