

**Critical Review:
Effectiveness of Sound Production Treatment (SPT) with individuals with apraxia of speech**

Nicole Pounds
M.Cl.Sc (SLP) Candidate
University of Western Ontario: School of Communication Sciences and Disorders

This critical review examines the effectiveness of Sound Production Treatment (SPT) with individuals with apraxia of speech. Experimental designs looking at this topic were all multiple baseline single subject design studies. The literature available provides evidence that SPT can be effective, as demonstrated in the limited number of studies published thus far. The results presented here need to be interpreted with caution as there have not yet been extensive investigations and there are inherent limitations in the methodologies used. Overall, the literature provides suggestive evidence that supports the use of SPT with individuals with apraxia of speech (AOS).

Introduction

Apraxia of speech (AOS) has been defined as a disturbance in one's ability to produce purposeful learned movements, despite intact mobility, secondary to brain damage (Knollman-Porter, 2008). It is characterized by sound production errors, distortions of prosody, and a slowed rate of speech. (McNeil et al 2000). The leading cause of apraxia of speech is stroke, and such it often co-occurs with aphasia (Brookshire, 2007). Apraxia of speech has been observed to respond positively to a variety of treatments. Treatment for AOS generally falls into one of the following categories of approaches: 1) articulatory-kinematic, 2) rate/rhythm control, 3) inter-systemic facilitation / re-organization, 4) alternative augmentative communication (AAC) (Chapey, 2008). Of the different types of treatment, articulatory-kinematic approaches have been reported as having the strongest evidence supporting their use (Wambaugh, 2010). Sound Production Treatment, developed in the 1990's, is an articulatory-kinematic treatment for apraxia of speech that combines modeling-repetition, minimal contrast practice, integral stimulation, articulatory placement cueing, repeated practice and verbal feedback, using aspects of principles of motor learning, in the format of a response-contingent hierarchy (Wambaugh, Mauszycki, 2010). The majority of stimuli used are real words and real words are used whenever possible. SPT was designed to promote improved articulation in specific sounds targeted for treatment and according to Wambaugh et al. (2010) has undergone more systemic examination than any other AOS treatment.

Objectives

The primary objective of this paper is to critically evaluate the available literature on the effectiveness of Sound Production Treatment with acquired apraxia of speech in the adult population. The secondary objective

is to state evidence-based recommendations and clinical implications regarding acquired apraxia of speech.

Methods

Search Strategy

A search of electronic databases including (PubMed, PsychINFO, CINAHL, Embase and the University of Western Ontario's library search engine) using the search terms (apraxia of speech) OR (apraxic) OR (dyspraxic) AND (sound production treatment) or (SPT) located the articles reviewed in this paper. The references from relevant articles found were also examined for possible inclusion. The search was limited to articles published in English but not limited by year of publication.

Selection Criteria

The articles included in this critical review were required to look at the use of Sound Production Treatment as a form of therapy on at least one individual diagnosed with acquired apraxia of speech.

Data Collection

The search and selection criteria described above yielded seven (7) research articles, all of which were multiple baseline single subject designs.

Results

All papers are multiple baseline single subject design studies involving adults presenting with acquired apraxia of speech and aphasia. All studies discussed had the following commonalities: Each provided detailed information about the treatment methodologies; stimuli used and test results were included in the paper. In depth participant information was given, including personal data and test scores. The designs of these studies were set up such that future clinicians could reproduce in a fairly easy and simply manner.

Appropriate inter-rater reliability was conducted and reached acceptable levels. It should be noted that one participant had possible upper motor neuron dysarthria.

Wambaugh et al (1998) examined the effects of treatment for sound errors using minimal contrast pairs with traditional SPT with one individual with apraxia of speech and aphasia. Treatment design involved an initial baseline phase, during which all items (both trained and untrained) were probed three times, followed by treatment sequentially of three groups of target sounds. A follow-up probe occurred six weeks post treatment. The authors observed that correct production of all target sounds were consistently lower throughout the baseline phase; initiation of treatment showed an increase in accurate productions. Sentence duration was also measured. Data was analyzed by visual inspection and percentage of correct productions. The authors found that SPT resulted in improvements in target sounds in both trained and untrained words and at follow up, correct productions for two of the three sound groups remained high, however some loss of treatment gains were observed post treatment. Sentence duration decreased. The Student-Newman-Kelus statistical test found baseline probed sentences were significantly longer than the later sentence probes.

In addition to the strengths and weaknesses previously listed for all studies review in this critical review, this study has particular strength due to the statistical analysis used. These positive results must be interpreted with caution as they may not generalize to other individuals with apraxia of speech. This study, being a multiple baseline single subject design, provides level 3 evidence when using the Oxford Centre for Evidence-based Medicine Levels of Evidence. Overall, this study provides suggestive evidence for improving the articulation of English consonants, as well as increasing the rate of speech when SPT is provided and thus provides support for the effectiveness of SPT.

In 1998, Wambaugh et al. examined treatment effects of acquisition of trained sounds and generalization to untrained sounds with SPT in a similar manner as previously discussed, this time with three participants. Treatment design involved an initial baseline phase, during which all items (both trained and untrained) were probed, followed by treatment sequentially of the three target sounds. A follow-up probe occurred six weeks post treatment. Data was analyzed by visual inspection and percentage of correct productions. The authors observed that the majority of trained sounds improved in accuracy, and long term maintenance effects remained strong at the follow up probe. Treatment effects were not extended to untrained sounds for two of the three participants but restricted

generalization to untrained sounds was observed for one participant.

These positive results must be interpreted with caution as they may not generalize to other individuals with apraxia of speech. This study, being a multiple baseline single subject design, provides Level 3 evidence when using the Oxford Centre for Evidence-based Medicine Levels of Evidence. Overall, this study provides suggestive evidence for improving the articulation of English consonants when SPT is provided and thus provides support for the effectiveness of SPT.

Wambaugh et al (1999) examined acquisition, overgeneralization and maintenance effects of SPT with one individual. Treatment design followed the same design as discussed previously and thus involved an initial baseline phase, during which all items (trained and untrained) were probed at minimal three times over various sessions, followed by treatment sequentially of the three target sounds in word initial position at the CV or CVC level. A follow-up probe occurred six weeks post treatment. The authors observed that correct production of all target sounds was consistently low throughout the baseline phase. Once treatment began an increase in accurate productions was observed. Data were analyzed by visual inspection and percentage of correct production of the target sound. The authors found that SPT resulted in improvements in trained sounds in both trained and untrained words and a follow up at six weeks found that correct productions for two of the three sounds remained high and the third sound still remained above baseline levels. The authors state that this study documented that overgeneralization during treatment can and did occur.

These positive results must be interpreted with caution as they may not generalize to other individuals with apraxia of speech. This study, being a multiple baseline single subject design, provides Level 3 evidence when using the Oxford Centre for Evidence-based Medicine Levels of Evidence. Overall, this study provides suggestive evidence for improving the articulation of English consonants when SPT is provided and thus provides support for the effectiveness of SPT.

Wambaugh (2004) looked at the acquisition of sounds and stimulus generalization effects to longer phrases and to trained utterances given without a verbal model with SPT with two individuals with acquired AOS. Treatment design involved an initial baseline phase, during which items (both trained and untrained) were probed at least three times, followed by treatment sequentially of the three target sounds. The authors observed that correct production of all target sounds were consistently lower throughout the baseline

phase; initiation of treatment showed an increase in accurate productions. The authors observed that correct production of all target sounds were consistently lower throughout the baseline phase; initiation of treatment showed an increase in accurate productions. Visual inspection of data was used to make a determination of treatment effects. The authors found that SPT increased the accuracy of trained phonemes in trained and untrained words.

These positive results must be interpreted with caution as they may not generalize to other individuals with apraxia of speech. This study, being a multiple baseline single subject design, provides Level 3 evidence when using the Oxford Centre for Evidence-based Medicine Levels of Evidence. Overall, this study provides suggestive evidence for improving the articulation of English consonants when SPT is provided and thus provides support for the effectiveness of SPT.

Wambaugh and Nessler (2004) desired to examine acquisition and stimulus generalization effects of SPT with one adult participant. Treatment design was in keeping with those previously described and involved an initial baseline phase, followed by treatment of the nine target sounds at the CV or CVC level, with a follow-up at two and six weeks post treatment.

The authors observed that correct production of all target sounds were consistently lower throughout the baseline phase; initiation of treatment showed an increase in accurate productions. Visual inspection was used to make a determination of treatment effects. The authors found an increase in the accuracy of target sounds in trained contexts. Generalization to different contexts was quite limited and not consistently observed. The target sounds were trained at the sentence completion level as well and treatment effect gains were found.

These positive results must be interpreted with caution as they may not generalize to other individuals with apraxia of speech. This study, being a multiple baseline single subject design, provides Level 3 evidence when using the Oxford Centre for Evidence-based Medicine Levels of Evidence. Overall, this study provides suggestive evidence for improving the articulation of English consonants when SPT is provided and thus provides support for the effectiveness of SPT. A study by Wambaugh and Matuszycki (2010) examined the acquisition, response generalization and maintenance effects of SPT on one individual. Six consonants, grouped into two sets of sounds were chosen as target sounds to be used in monosyllabic words. An initial baseline phase occurred in which five probes of each target sound were taken. SPT was applied in the form of the response contingent hierarchy to set 1 target sounds for 25 sessions. Treatment then ceased for

set 1 sounds and extended to set 2 sounds for 25 sessions. A third phase then occurred in which treatment was applied to both sets of target sounds simultaneously. Follow up probes occurred at 10 weeks and 15 weeks following the completion of therapy sessions. Data were analyzed by visual inspection. After the treatment phase for set 1, increases in accuracy of two of the three sounds was observed in both trained and untrained words. After the treatment phase for set 2, accuracy increased for all three. After treatment was applied to all sounds simultaneously, increases to high levels of accuracy were observed for four of the sounds. Follow up probes showed increases remained in four of the six sounds but accuracy levels did not remain stable and dropped. The conservative dual-criteria (CDC) method was used to aid in the visual inspection to make a determination of treatment effects. The authors found that according to this CDC method, a reliable treatment effect was achieved for four of the sounds.

In addition to the strengths and weaknesses previously listed for all studies reviewed in this critical review, this study has particular strength due to the CDC statistical method of analysis used. These positive results must be interpreted with caution as they may not generalize to other individuals with apraxia of speech. This study, being a multiple baseline single subject design, provides Level 3 evidence when using the Oxford Centre for Evidence-based Medicine Levels of Evidence. Overall, this study provides suggestive evidence for improving the articulation of English consonants when SPT is provided and thus provides support for the effectiveness of SPT.

Maas et al (2002) examined the effects of using simple versus complex stimuli with two individuals with apraxia of speech and aphasia. This research did not follow the hierarchy as described by Wambaugh et al. in the other studies. Their paper does however list that they are working on Sound Production Treatment. The intent of the paper was to compare types of stimuli, but as they did so they used a treatment regime involving repetition, modeling, articulatory placement cues, and reading. Treatment design involved an initial baseline phase, during which items were probed repeatedly, followed by a treatment protocol using both simple and complex stimuli. No follow up probe occurred. The authors observed that correct production of the target stimuli increased. Data were analyzed by visual inspection and percentage of correct productions, as well as statistical analysis.

These positive results must be interpreted with caution as they may not generalize to other individuals with apraxia of speech. This study, being a multiple baseline single subject design, provides level 3 evidence when using the Oxford Centre for Evidence-based Medicine Levels of Evidence. Overall, this study

provides limited evidence for improving the articulation of English consonants when a treatment regime with components similar to SPT.

Discussion

The studies reviewed in this paper found that SPT had a positive impact on the speech of the individuals with AOS who were participants. There are the following limitations to be considered when summarizing the results:

Single subject designs were used in all studies. This was an appropriate design method for a rare population such as AOS, however single subject designs have an inherent lack of external validity, as the results cannot be readily generalized to other individuals with AOS and as such the ability to generalize is limited. Each study reviewed had a sample size of three or less and such a limitation is the small number of participants. This is an on-going issue when conducting research with rare populations; however it is still a limitation to the evidence.

Each study collected multiple baseline data which is an important component to single subject design studies. It is desirable to take these baseline measurements repeatedly and over multiples days. Doing so can increase the authors confidence that the differences they find post treatment truly are reflective of the treatment. Each paper probed the majority of target words each at least three times, over three sessions; this gives added support for the evidence of the papers.

Having multiple well designed single subject studies can increase the level of evidence that the above mentioned reviewed studies have collectively. Over a time span of approximately twelve years, Wambaugh and various other research partners have conducted six published studies with near identical design and purpose. Consistent core findings were found, and thus each study builds upon the previous one in some aspects, thus increasing the support for the effective treatment effects with SPT. While having multiple well designed single subject studies builds support, it can be noted that had more studies been performed by other authors, the credibility of treatment would be increased. According to this literature search, it appears as though the specific Sound Production Treatment hierarchy has not been studied by any author working separately from Wambaugh.

All participants included had been diagnosed with apraxia of speech (and aphasia) by a Speech-Language Pathologist. One issue with the diagnosis of AOS is that there is currently a lack of consensus

regarding diagnostic criteria and there is not one designated protocol for diagnosis of this disorder. Based on the information provided, it appears as though all authors have selected participants with a diagnosis of AOS to the best standard available; however there remains an inherent aspect of concern as to whether all participants do in fact have the exact same underlying disorder. Participant recruitment information was missing from all studies.

It can be noted that slight adjustments have been made to this treatment protocol as the SPT hierarchy has been modified slightly. The positive aspect to this is that results are being used in a functional manner and adjustments are being made to better aid the client, but none the less, the reader should be aware of this.

Using the 14 questions as discussed in Single-Subject Research Design: Recommendations for levels of Evidence and Quality Rating (Logan, L et al, 2008), three studies by Wambaugh et al. were found to be in the moderate category; the remaining four studies were found to be in the strong category.

One participant had participated in a previous study in which he received SPT. This may have affected his results as he had demonstrated positive outcomes previously and was thus familiar with the treatment. However, one can view this as a follow up study, which provides a more long term look at the progress of an individual provided with SPT.

Little to no generalization across sounds was observed in the studies discussed. This could potentially be considered a limitation to the treatment itself, not to the quality of research itself.

The effectiveness of SPT has been studied with only a few participants; however these well designed multiple baseline single subject designs discussed here do provide empirical support for its effects with individuals with all degrees (mild, moderate and severe) of apraxia of speech. SPT has been observed to increase the accurate productions of consonants as well as decrease the length of time it takes an individual with AOS to complete a phrase or sentence; both of which aid to counteract two of the common speech alterations experienced by individuals with AOS.

Conclusion

This comprehensive review of the literature examined research studies exploring the effectiveness of SPT with individuals with apraxia of speech. While there is a great need for future research in this area, the

literature available provides suggestive evidence that supports the use of SPT with individuals with apraxia of speech.

Clinical Implications

Currently there is no designated most effective treatment for AOS. Multiple approaches are used, and as a whole, further research is needed in order to determine effective treatment regimes for individuals with AOS. This critical review has shown that there is some empirical evidence suggesting SPT can be effective with individuals with acquired AOS. It is felt that SPT is an appropriate treatment protocol to trial with AOS clients in all clinical settings.

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