Critical Review: Is Rapid Syllable Transition Treatment (ReST) an effective therapy option, compared to no therapy, for treating individuals with childhood apraxia of speech?

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The present study is a critical review investigating the effectiveness of Rapid Syllable Transition (ReST) therapy for treating children with apraxia of speech (CAS). Using computerized databases, a literature search was performed and five articles were included in the evaluation. These studies determined the effectiveness of ReST treatment when delivered by both the clinician and the parent, the effect of a lower-dose frequency, the effectiveness of telehealth delivery, the effect when combined with orthographic cues and finally a comparison of ReST to another widely used treatment option for CAS. All studies were evaluated using a critical appraisal worksheet to identify relevant information, to assess the validity of the articles and to determine the level of evidence they provide. Overall, ReST has suggestive evidence to warrant it's use in treating children with apraxia of speech under ideal conditions.

Introduction

Childhood Apraxia of Speech (CAS) is a motor speech disorder that results in difficulties programming and planning the movements that are required for speech. This complex disorder results in inconsistent sound errors, disruptions in co-articulatory transitions, and reduced stress variation across words and phrases (American Speech-Language-Hearing Association, 2007). It is known that children with apraxia of speech respond slower to treatment and therefore require practice at higher frequencies and intensities to demonstrate improvements.

One of the methods that is widely used to treat this disorder is called Rapid Syllable Transition Treatment (ReST). ReST is based on the principles of motor learning and is considered to be effective when delivered four times a week, for three consecutive weeks, by a skilled clinician. The treatment aims to improve the speech sound production and prosody of children with apraxia of speech by using pseudo words that vary in their stress patterns.

ReST treatment sessions contain two phases: pre-practice and practice. The skills and stimuli are introduced in the pre-practice phase, which allows the child to attempt the new skill. The child is also provided with additional support and cueing by the clinician to encourage a correct response (Murray et al., 2015). This phase also promotes self-monitoring and allows the child to recognize their own errors. During the practice phase, the child is required to complete a high number of trials, while working on more than one skill (variable practice). Additionally, the stimuli are presented at random and the child receives knowledge of results feedback after a 3-to-5 second delay (Murray et al., 2015).

The complexity of CAS makes it challenging for researchers to develop a treatment program that will follow the principles of motor learning and demonstrate efficacy. Additionally, it is challenging to develop a program that is clinically feasible with respect to time and resources. Therefore, it is important to examine the existing literature to determine whether ReST intervention is appropriate for treating the sound errors, the incorrect stress patterns, and the improper sound transitions that occur in childhood apraxia of speech.

Objectives

The primary objective of this paper is to critically review the current evidence regarding the effectiveness of ReST therapy for treating children with apraxia of speech. The secondary objective of this paper is to provide clinical recommendations for Speech Language Pathologists (SLPs) who may consider ReST treatment when working with children diagnosed with apraxia of speech.

Methods

Search Strategy: Articles related to the topic of interest were found using a variety of databases, including PubMed, Scholars Portal and Western Library Databases. The search was limited to articles written between 2010 and 2019. The following keywords were used for the database search:
[(Childhood Apraxia of Speech) AND (Treatment) AND (Effectiveness) AND (ReST) OR (Rapid Syllable Transition Treatment)].

Selection Criteria: To be included in this review paper, studies selected investigated children who were diagnosed with or met criteria consistent with Childhood Apraxia of Speech and who received individual ReST treatment. Variations of ReST therapy were also included to determine the overall effectiveness of the therapy in a variety of circumstances.

Data Collection: The results of the literature search yielded five articles that met the selection criteria. There were four single-subject designs and one randomized control trial.

Results
Single-Subject Designs
As a result of a relatively small subject population, single-subject designs are useful for testing hypotheses related to childhood apraxia of speech. In this type of research, the participant is acting as their own control. Single-subject designs provide a high level of evidence; however, caution must be used when interpreting the results as it may not be representative of the general population.

Thomas, McCabe and Ballard (2018) used a multiple baseline, across participant's design, to evaluate the effectiveness of ReST therapy in five children with CAS when delivered by both the clinician and the parent. The parent-child dyads completed 12 treatment sessions over three weeks and they were randomly assigned to receive three-to-five baseline probes prior to beginning therapy. The children's performance was assessed three times throughout the treatment period and three times during the follow-up period. Researchers used a probe list that contained the treated pseudo words, untreated pseudo words and real words. Responses were phonemically transcribed and scored as correct or incorrect in terms of phonemes, lexical stress, and fluency of syllable transitions. These were used as the outcome measures to assess the acquisition, maintenance and generalization effects of the ReST treatment.

Results of the present study indicate that four of the five children had a significant treatment effect on one or more of the treated behaviours, with an average effect size of 5.55. This value was compared to a previous study where ReST was delivered by the clinician only, which had a greater effect size of 6.46. It was found that four children showed some degree of generalization; however, two of the children had significant generalization to the majority of the pseudo and real words. All four children maintained treatment gains four months' post-treatment. The effectiveness of the parent-delivered approach was negatively influenced by a variety of factors including the fidelity of the treatment, the inter-rater reliability of perceptual judgments, and child and parent factors.

Thomas, McCabe and Ballard (2018) presented a thorough description of the inclusion criteria, the initial participant assessment results and the reliability procedures. Additionally, the intervention methods and fidelity protocols were well described. The use of multiple baseline measures, randomization, and appropriate statistical analysis using effect size, are considered to be strengths of the study. The present study did not include a maturational control group or a description of the exclusion criteria and had a small sample size, which are limitations to the study.

Despite the weaknesses of the study as outlined above, this study offers suggestive evidence that ReST therapy is effective when delivered by both the clinician and the parent. In previous studies, larger treatment and generalization outcomes were reported when ReST was delivered by the clinician alone. This should be considered when choosing a delivery method.

Thomas, McCabe & Ballard (2014) also conducted a multiple-baseline, across participant's design to determine if ReST is an effective treatment approach when it is delivered at a lower frequency dose. The four participants who were recruited for the study were between four and eight years old and they received ReST treatment twice a week, for six weeks. During the baseline phase, participants imitated treated and untreated items on their probe list, between three and six times. From a 120-item probe list, 20-items were randomly selected for treatment while the others were used to assess generalization of untreated items. Responses were phonemically transcribed and the stress pattern and the fluency of the syllable transitions were scored as accurate or inaccurate. These were used as the outcome measures for the study.

Appropriate statistical analysis demonstrated significant improvements in the production of the target items and generalization to untreated real words across all four participants. During the maintenance phase, all children retained their skills up to four-months post treatment with a stable profile.

Protocols were well described for reliability and fidelity and the results calculated were deemed acceptable. An unfamiliar clinician was assigned to assess each child during the probe sessions, which reduced the potential for bias. Recruitment data, inclusion criteria and initial assessment results were also well reported. Limitations of the study include the lack of a control group and the small sample size. These limitations may make it challenging to interpret the variations, as the results may be due variables within the client.

Overall, this study provides highly suggestive evidence that a lower-frequency dose (two days a week) of ReST therapy has similar effects in acquisition to the higher-frequency dose (four days a week).

Thomas, McCabe, Ballard, Lincoln (2015) also used a multiple baseline, across participant's design to look at the effectiveness of ReST therapy when it was delivered via video-conference. This alternative service delivery was provided to five children with apraxia of speech between the ages of five and eleven. Participants received baseline sessions twice a week for three to six weeks. Children met face-to-face with the clinician to collect the initial assessment data and the baseline information. Adobe Connect technology was used to transmit real time audio and visual information. Performance was measured three times during the treatment and three times post-treatment. The same procedures for ReST were used; however, instead of reading the items, children imitated the items while looking at the written stimuli. The outcome measures of the study were based on perceptual judgments about the accuracy of the phonemes, stress pattern and fluency of syllable transitions for the probe items.

Results of each individual child were well documented and all five children made positive improvements throughout the three-week treatment. Each participant showed large effect sizes in the acquisition of pseudo words. These values were similar to other studies where ReST was delivered face-to-face. All five children were able to generalize their skills to untreated but related words. In terms of maintenance, four of the children were shown to maintain these gains up to four-months after treatment. Although positive gains were made, the clinicians reported technical challenges that may have interfered with the progress of some the children. Parents were satisfied with the telepractice delivery method and reported it to be convenient and motivating for the child.

Appropriate statistical analysis was performed using ANOVA and Helmert planned orthogonal contrasts. Where possible, visual analysis was supported with these statistical analyses. The study included thorough descriptions of the inclusion criteria, patient characteristics and technology used, which allows the study to be easily replicated. Fidelity protocols were well described and the average fidelity score across treatment sessions was acceptable (95%). In addition, intra- and inter-rater reliability measures were individually calculated for the pseudo words, real words, and control items. All were within the acceptable range (78.5%-95%). Researchers also used an experimental control by replicating the treatment effects across participants by staggering the treatment across different time points. These are all considered strengths of the present study.

A major limitation of this study is the small sample size. Including only five participants in the study provides clinicians with a narrow view into how effective telehealth delivery is for the general population of children with apraxia.

The results from this study provide preliminary evidence to suggest ReST treatment is effective for treating children with apraxia of speech when delivered via telehealth. More research involving larger groups is required to confirm the results of this study and to investigate additional factors that may contribute to treatment outcomes.

McCabe, D'Silva, van Rees, Ballard, Arciuli (2014) performed a within-subject, single case, AB design to determine if using ReST with orthographical cues is effective for improving lexical stress. Participants included four children with CAS, who participated in weekly sessions, four times a week, for three weeks. Bilsyllabic, pseudo word stimuli were used throughout this study and they were orthographically presented on flash cards. The stimuli were biased to either a strong-week or a weak strong stress patterns. It was proposed that presenting a written word in conjunction with instruction on the production may facilitate success in stress production. Baseline sessions occurred three times over the course of the study, and experimental probes were administered after every fourth session. Additionally, researchers collected samples of connected speech to determine the effects of generalization in a more ecologically valid context. During the practice phase, the stimuli were randomly presented, and each child was responsible to read the word aloud or repeat the word after the clinician for at least 100 trials. Knowledge of results was provided about 50% of the time for prosodic and segmental accuracy. Researchers used perceptual judgments based on three components for the outcome measures: stress pattern correct, all segments correct, and simultaneous accuracy of stress and segments.

Results of the present study provide preliminary evidence to suggest ReST therapy in conjunction with orthographic cues is an effective approach for treating lexical stress in children with apraxia of speech. Perceptual judgments were made on prosodic, segmental and combined accuracies (both stress pattern and correct phoneme) and over the course of the treatment, all children were found to perceptually improve their lexical stress contrasts and segmental accuracy. The magnitude of improvement of the treatment effect and maintenance varied among all participants. The results showed two of the four participants were able to independently read stimuli. These children demonstrated improved productions of treated words, and the treatment effect was found to generalize to untrained items and connected speech.

Participants also improved in their segmental accuracy and also demonstrated generalization to connected speech. All participants had difficulty producing both correct stress patterns *and* correct segments.

Reliability protocols were well described and reliability scores were calculated for response accuracy, phonemic transcription and perceptual scores. All were considered acceptable (83%-97%). Individual fidelity scores along with a mean fidelity score of 75% were provided. Reduced fidelity scores was attributed to the errors in providing feedback after a three-second delay. Details regarding inclusion criteria and the use of an experimental control group serve as strengths for the study.

The present study also had various limitations that reduces the overall strength of the results. Similar to previous studies, the small sample size is a significant limitation, as it may not be representative of the general population. Additionally, the use of perceptual judgments and relying on visual analysis of the data reduces the quality of the data. Introducing statistical analysis beyond percent nonoverlapping data (PND) analysis would improve the quality of the data. The design of this study is also considered a limitation as the ability to determine generalization is limited.

Overall, this study provides preliminary evidence to suggest ReST treatment is effective with orthographical cues to improve lexical stress in children with apraxia of speech. Larger sample sizes, an improved study design and more descriptive statistical analysis are required to confirm the results of the present study.

Randomized Controlled Trials (RCTs)
Randomized controlled trials provide high levels of evidence and are often used to compare the effectiveness of two treatments. RCTs eliminate sources of bias by randomly allocating participants to different treatment groups and may also use blinding to improve the overall quality of the study.

Murray, McCabe & Ballard (2015) used a parallel group, randomized control group to compare the effectiveness of ReST, and another widely used program to treat CAS, the Nuffield Dyspraxia Programme (NDP3). Researchers recruited 26 children diagnosed with idiopathic CAS to participate in the study. All participants were between four and twelve years of age and received one hour sessions of either ReST of NDP3, four times a week, for three consecutive weeks. Children were evaluated using experimental probes at one week, one month and four months', post-treatment. Primary treatment outcomes of the study included: treatment gains, maintenance of

treatment gains for treated items, and expected response generalization to untreated real words and pseudo words using experimental probe items. Secondary treatment outcomes included multiple measures of generalization.

Appropriate statistical methods (repeated measures ANOVA and ANCOVA) were used to determine treatment efficacy. Both treatment groups demonstrated a large effect size, with the NDP3 group making greater gains in production accuracy (d=2.162) compared to the ReST group (d= 1.312). When considering the maintenance of the effects of treatment, it was found that the ReST group made a small increase in accuracy one-month post-treatment (d=0.420) and the NDP3 showed a small decrease in accuracy on the treated items (d= -0.206). Similar effects were shown four-months post-treatment. Both groups showed significant improvements in accuracy when generalizing to real words. The ReST group demonstrated a larger increase (d=1.376) in the accuracy in the generalization to untreated pseudo words compared to NDP3 (d=0.319).

The study included many strengths that improve the overall quality of the research. Participant recruitment methods and the inclusion criteria were well described. Fidelity and reliability protocols were well reported and the measures were considered acceptable. Randomization was well reported and the use of partial-blinding with the parents (to the name of the treatment) and therapists (to the study's hypothesis) strengthen the overall evidence of the paper.

There are also limitations to the present study. A control group should have been to used to control for any maturation factors and would have provided more confidence when comparing the two treatments. As well, full blinding procedures were not used. Parents were able to observe the treatments given to their child and therapists were aware of which treatment was being provided to every child. These limitations may bias the results and reduces the overall strength of the paper.

The use of a randomized, clinical trial along with the other strengths of this paper significantly outweigh the limitations. This study offers strong evidence to suggest that ReST and NDP3 are both effective options for treating childhood apraxia of speech. Depending on the goals, ReST may be more appropriate if the target is maintenance and generalization, while NDP3 may be more appropriate if the primary goal is production accuracy.

Discussion
Overall, the results of the five studies reviewed suggest that ReST treatment, under ideal conditions, is an

effective treatment approach to use with children who have apraxia of speech. Various modifications can be applied to ReST therapy that may serve to benefit children with apraxia of speech.

One paper modified the intensity of ReST treatment to a lower dose, providing suggestive evidence of a similar benefit in acquisition and generalization. Although these benefits did not continue to improve post-treatment, as they did in the high-frequency dose, it may be a more realistic and sustainable option for clinicians to consider. Caution should be exercised when involving parents in the delivery of ReST therapy. Equivocal evidence was provided by the research, showing reduced treatment effects and generalization compared to when treatment is provided by the clinician alone.

When the mode of service delivery was modified to telehealth, improvements were also made in the acquisition, generalization and maintenance of skills. This study provides preliminary evidence to suggest that video-conferencing is an effective method for delivering ReST therapy. With the advancements in technology, these suggestive results are very important, as it may allow clinicians to provide ReST therapy to remote or isolated populations. Using orthographically-sensitive words should be used with caution, as equivocal evidence was provided in this study. Due to the small sample sizes of these studies, more research is required to determine if these benefits will occur in the general population of children with CAS. However, compelling evidence was provided in the study comparing ReST therapy to the NDP3 program. High quality evidence suggested ReST to be an effective therapy option for treating CAS, especially when targeting maintenance and generalization.

It is also important to note that the five studies presented in this review were derived from the same author group who developed ReST treatment. Additional studies from third party researchers to test the efficacy of ReST should be completed to validate the efficacy and provide additional strength to the evidence.

Clinical Implications
The articles presented in this review provide suggestive evidence and important findings that will be useful in an SLPs clinical practice. Based on the critical appraisal, the use of ReST treatment for children with CAS is recommended to improve acquisition of skills, and minor modifications may be used to maximize maintenance and generalization. Clinicians must refer to the evidence to determine how to modify ReST to individualize and optimize treatment effects. It is

always important for clinicians to integrate the best available evidence with their clinical judgment and patient values to provide their clients with the best evidence-based care.

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