

**Critical Review: In children with Childhood Apraxia of Speech (CAS), is Rapid Syllable Transition (ReST) an effective intervention program for improving prosody outcomes and under what parameters of delivery?**

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***Abstract***

This critical review examines the current literature on Rapid Syllable Transition (ReST) as a new intervention program for children with CAS. Study designs included a randomized control trial, five single-subject designs and a qualitative parent interview. The evidence gathered revealed a highly suggestive level of evidence for the ReST treatment protocol. Evidence either supporting or not supporting alterations to different delivery parameters is limited. Further investigation is required to strengthen the current findings.

***Introduction***

Childhood Apraxia of Speech (CAS) is a motor speech disorder that affects motor planning and programming. ASHA (2007) identifies three core features prevalent in CAS: inconsistent segmental errors, co-articulation errors and prosody errors. Treatment to date, primarily focuses on improving segmental errors rather than targeting co-articulation and prosody (Ballard et al., 2010). Symptoms of CAS continue to persist into adulthood (Ballard et al., 2010).

The Treatment: Rapid Syllable Transition (ReST) is an intervention program developed by Speech Language Pathologists (SLP) at the University of Sydney to address lexical stress in children with CAS. The authors of ReST have provided a thorough outline of the intervention in the clinician manual. The program uses pseudo-words (e.g. teebaki) to allow random sequencing of syllables thus increasing the variety of transitions practiced and to simulate rapid planning movements and movement sequences without the influence of learned motor plans and linguistic representations (Ballard et al., 2010). Principles of motor

learning are incorporated into this intervention program to assist in generalization of treatment effects.

The program is designed to occur four times a week for three weeks, averaging 100 trials per session, for a total of approximately 1200 trials. The intervention includes a pre-practice and practice phase, while incorporating various principles of motor learning. During the pre-practice phase of each session, the clinician provides knowledge of performance (KP) feedback and helps shape the correct response. During the practice phase, the clinician gives knowledge of results (KR) feedback after a delay of 3-5 seconds. The feedback occurs on 100% of the first ten items, 90% of the next ten items, fading to 10% on the last ten items (Thomas et al., 2014).

There is currently very little evidence regarding the treatment of prosody in children with CAS. This literature review is designed to evaluate ReST as a new treatment program and to determine under what parameters is it effective.

## ***Objective***

The primary objective of this review is to critically analyze the existing literature on the treatment effects of ReST intervention. The secondary objective is to determine which parameters of ReST are crucial for its effectiveness, and how these can be incorporated into current speech and language intervention practice.

## ***Methods***

### Search Strategy:

Online databases searched included the following: PubMed, Google Scholar and ScienceDirect and ASHA publications. Search terms included: [(childhood apraxia of speech) OR CAS] AND [(Rapid Syllable Transition) OR ReST] AND [treatment OR prosody]. References lists of identified studies were searched.

### Search Criteria:

Studies that investigated the efficacy of ReST and/or manipulated the parameters of the treatment protocol were included. Subjects in all studies were required to have received a diagnosis of CAS using a gold standard assessment.

### Data Collection:

Search results of the literature generated seven articles including one randomized control trial, five multiple baseline single subject designs and one qualitative interview. Of the findings, two addressed the efficacy of ReST, and the remainder evaluated specific parameters of ReST.

## ***Results***

### Efficacy of ReST

**Murray et al. (2015)** conducted a randomized control trial to compare the treatment effects of ReST and another well-

known apraxia intervention program, the Nuffield Dyspraxia Programme-3<sup>rd</sup> edition (NDP-3; Maas, 2015) in 26 4-12 year-olds with varying degrees of CAS severity. Baseline equivalence on relevant measures between groups was reported. Appropriate a priori sample size calculation for adequate power, intention to treat (due to one dropout) analyses, and statistical analyses were reported.

Treatment dose (60 minutes session; 4 days/week) was equal across groups, student clinicians were blinded to the study hypothesis and each provided therapy to one participant in each group. Measures of speech production accuracy on real and pseudo trained and untrained words were collected at prior to, and 1 week, 1 month, and 4 months after treatment. From these, treatment gains, maintenance of treatment gains and generalization scores were calculated. Adequate interrater reliability for correct articulation, co-articulation and prosody were reported.

Results of the study revealed large treatment effects for both treatments, with greater effects for NDP-3 at 1 week post-treatment. Treatment maintenance between 1 and 4 weeks post, and generalization were greater for ReST.

Overall, this study provides compelling evidence that ReST and NDP-3 are effective intervention programs.

**Ballard et al. (2010)** conducted multiple baseline single subject design study to investigate the efficacy in treating dysprosody in 3 children with CAS (2 males; 7-10 year-olds). Acoustic measures of duration (vocal intensity and fundamental frequency also noted) were compared to perceptual measures of correct production, and recorded to determine treatment effects

of strong-weak (SW) and weak-strong (WS) non-words, generalization to more and less complex items and maintenance of treatment effects. Strong relationships between acoustic and perceptual measures revealed competency of perceptual objective measurements. Appropriate statistical analysis was completed.

Results revealed all children improved their lexical duration/prosody; improvements in loudness and pitch noted despite not being explicitly addressed. Greater generalization noted in less complex tasks than more complex tasks. Two children (with milder impairments) showed no or minimal deterioration on treated items at 4-weeks post treatment and the child with a more severe diagnosis of CAS did not retain treatment effects.

Overall, this study provides suggestive evidence for the efficacy of ReST intervention for children with CAS.

#### Parameters of ReST

**Thomas, McCabe and Ballard (2014)** conducted a multiple baseline single subject design study with four children (2 males; 4-8 year-olds) with CAS to determine the effectiveness of twice-weekly ReST treatment for six weeks (with no other alterations to the treatment protocol). Outcome variables included measurements of production accuracy on treated and untreated pseudo-words and untreated real words, and were collected during pre-treatment, throughout the treatment and 1 day, 1 week, 4 weeks and 4 months post-treatment. Acceptable intra- and interrater reliability was reported, appropriate statistical analyses including calculation of effect sizes were noted.

Results of the study showed positive treatment effects for all children at post

intervention, and maintenance (with no further growth) at follow-up. Generalization was observed consistently across participants for real words, but inconsistently for pseudo-words. The 2 children who demonstrated better generalization began the study with better speech at initial assessment.

Overall, this study provides suggestive evidence that ReST is effective for improving and maintaining prosody skills when delivered with a lower dose-frequency design.

**Thomas, McCabe and Ballard (2017)** conducted a multiple baseline single subject design study to determine treatment effectiveness of ReST when administered with a combined clinician-parent delivery model. Participants included five child-parent dyads who met specific and relevant criteria. Six ReST sessions were administered by the clinician, and six by the parents. Parent training occurred throughout the initial clinician-directed sessions and feedback was given to the parent throughout the study upon reviewing audio recordings from home. Outcome measures included accurate production on treated items, generalization to untreated items and treatment fidelity.

Results revealed improvements on all treated items for 2 children, some treatment effects for 2 children and no treatment effects for the remaining participant. Generalization to untreated items were noted in two children. Gains were maintained at four-months post-treatment. Treatment fidelity was higher for clinician- than parent-delivered sessions with providing accurate perceptual feedback identified as most challenging.

Overall, this study provides suggestive evidence that combined clinician-parent

delivery of ReST is less efficacious than delivery by clinician-only.

**Thomas, McCabe, Ballard and Lincoln (2016)** conducted a multiple baseline single subject design with five children (4 male; 5-11 year-olds) with CAS to determine the efficacy of administering ReST via telehealth while abiding by the standard ReST protocol. Objective outcome measures included accuracy of production to treated items, generalization and maintenance of behaviours. Subjective outcome measures included parent satisfaction, child motivation, convenience and level of technical difficulties. Adequate participant selection, appropriate assessment considerations and statistical analysis were completed. Good treatment fidelity, intra- and interrater reliability noted.

Results indicated all five participants showed significant improvements to treated items and generalized to treated and untreated items. Four children maintained treatment effects at 4-months- post-treatment. Subjective measures were reported to be high, with some technical difficulties noted.

Overall, this study provides highly suggestive evidence that telehealth is an effective delivery model for ReST intervention for children with CAS.

**Thomas et al. (2017)** completed a qualitative study review parents' experiences with ReST following their participation in either the combined clinician-parent or telehealth delivery studies (Thomas et al., 2017; Thomas et al., 2016). The participants included 5 parents from each delivery model (1 male). Outcome measures included themes and subthemes analyses of service deliveries and overall parent report of ReST as a new

intervention protocol. Generally, parents reported more positive experiences with telehealth over the combined parent-clinician delivery option. Parents reported general satisfaction with the ReST program; some queried the principles of motor learning used and the use of pseudo-words. No qualitative data was given regarding overall satisfaction.

Overall, this study provides suggestive evidence that parents prefer telehealth and that they perceive ReST as an effective intervention program.

**McCabe et al. (2014)**, conducted a multiple baseline single subject design with four children (4 male; 5-8 year-olds) with CAS to determine the effects of orthographically biased pseudo words to improve prosody. Two participants could read independently and two imitated the stimulus following clinician model.

Outcome measures included accuracy on trained and untrained items, connected speech samples (percentage vowels correct [PVC], percentage consonants correct [PCC] and percentage correct stress patterns) and an experimental control assessing receptive language skills. Treatment effects and generalization varied among all participants. All children demonstrated improvements in lexical stress in connected speech with varying PVC and PCC. The experimental control reported no systematic change relative to treatment. Appropriate statistical analysis and reliability were present.

This article provides equivocal evidence when trying to determine the effect of orthographically sensitive stimuli.

## ***Discussion***

With the exception of ReST, there is currently no evidence of treatment addressing prosody (Ballard et al., 2010). The authors of this intervention program have designed this program to address all three core features of CAS. The current literature review examined the effectiveness of ReST, and the parameters which could be manipulated in order to best maintain its treatment effects. The review consisted of one randomized control trial, five single-subject and one qualitative review.

All of the studies in this critical review were authored by a small group of clinicians who designed or worked closely with the development of the program. This provides strong evidence that there was good treatment validity across studies; however, there is a lack of reported evidence on the program's efficacy across clinicians. Some clinical bias may have been reported within the studies. Currently, the evidence is based on studies with small sample size and single reports of parameter manipulation.

Overall, there is suggestive evidence that ReST is an effective treatment program when delivered as it was intended to be executed. The principles of motor learning embedded into the program led to generalization and maintenance of skills (Murray et al., 2015). Generalization was greater in children with a more mild diagnosis of CAS (Ballard et al., 2010 & Ballard et al. 2014).

Results of the studies revealed that manipulations of the dose-frequency, use of orthographic stimulus and providing therapy via telehealth yielded treatment effects, maintenance and generalization. However, the greatest outcomes were noted when ReST was delivered in its original form. The combined parent-clinician delivery model

was the least effective. Generally, parents reported satisfaction with ReST.

### ***Future Research Considerations***

Further research is suggested given the limited evidence in the current literature. In order to improve the level of evidence, the following recommendations for future research should be considered:

- I. Increase the sample size of the studies to strengthen results.
- II. Include a standard ReST delivery control group when comparing each parameter manipulations.
- III. Include follow-up beyond 4 months to evaluate maintenance of skills.
- IV. On-going exploration of treatment effects when delivered by various clinicians.

### ***Clinical Implications***

As discussed, there is currently limited evidence of treatment for children with CAS (Ballard et al., 2010), despite the awareness that children with CAS require intensive therapy and for longer periods of time (Thomas et al., 2016). ReST is an innovative treatment approaches designed to treat all three core features of CAS. These studies illustrate that ReST is an effective treatment program, and may include various manipulations by the clinician to suit his/her caseload while continuing to see the benefits of the program.

### ***References***

- American Speech-Language-Hearing Association. (2007a). *Childhood apraxia of speech* [Technical report]. Available from [www.asha.org/policy](http://www.asha.org/policy).

- Ballard, K. J., Robin, D. A., McCabe, P., & McDonald, J. (2010). A treatment for dysprosody in childhood apraxia of speech. *Journal of Speech, Language, and Hearing Research, 53*(5), 1227-1245
- Maas, E., Gildersleeve-Neumann, C. E., Jakielski, K. J., & Stoeckel, R. (2014). Motor-based intervention protocols in treatment of childhood apraxia of speech (CAS). *Current developmental disorders reports, 1*(3), 197-206.
- McCabe, P., Macdonald-D'Silva, A. G., van Rees, L. J., Ballard, K. J., & Arciuli, J. (2014). Orthographically sensitive treatment for dysprosody in children with Childhood Apraxia of Speech using ReST intervention. *Developmental neurorehabilitation, 17*(2), 137-145.
- McCabe, P., Murray, E., Thomas, D., & Evans, P. (2017). Clinician Manual for Rapid Syllable Transition Treatment. The University of Sydney, Camperdown, Australia.
- Murray, E., McCabe, P., & Ballard, K. J. (2015). A randomized controlled trial for children with childhood apraxia of speech comparing rapid syllable transition treatment and the Nuffield Dyspraxia Programme—Third Edition. *Journal of Speech, Language, and Hearing Research, 58*(3), 669-686.
- Murray, E., McCabe, P., & Ballard, K. J. (2012). A comparison of two treatments for childhood apraxia of speech: Methods and treatment protocol for a parallel group randomised control trial. *BMC pediatrics, 12*(1), 112.
- Murray, E., McCabe, P., & Ballard, K. J. (2014). A systematic review of treatment outcomes for children with childhood apraxia of speech. *American Journal of Speech-Language Pathology, 23*(3), 486-504.
- Thomas, D. C., McCabe, P., Ballard, K. J., & Bricker-Katz, G. (2017). Parent experiences of variations in service delivery of Rapid Syllable Transition (ReST) treatment for childhood apraxia of speech. *Developmental neurorehabilitation, 1*-11.
- Thomas, D. C., McCabe, P., & Ballard, K. J. (2017). Combined clinician-parent delivery of rapid syllable transition (ReST) treatment for childhood apraxia of speech. *International Journal of Speech-Language Pathology, 1*-16.
- Thomas, D. C., McCabe, P., Ballard, K. J., & Lincoln, M. (2016). Telehealth delivery of Rapid Syllable Transitions (ReST) treatment for childhood apraxia of speech. *International journal of language & communication disorders, 51*(6), 654-671.
- Thomas, D. C., McCabe, P., & Ballard, K. J. (2014). Rapid Syllable Transitions (ReST) treatment for childhood apraxia of speech: the effect of lower dose-frequency. *Journal of communication disorders, 51*, 29-42.