Clinician Manual for Rapid Syllable Transition Treatment (ReST)

Patricia McCabe, Elizabeth Murray, Donna Thomas and Pippa Evans

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For more information about ReST or to participate in research, please contact Tricia McCabe PhD, tricia.mccabe@sydney.edu.au

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Rapid Syllable Transition Treatment
known as ReST

Introduction

This treatment was originally designed to directly address the underlying motor planning and programming problems experienced by children with Childhood Apraxia of Speech (CAS also dyspraxia), particularly with managing lexical stress and transition from sound to sound or syllable to syllable (ASHA, 2007).

We aimed to use as many of the principles of motor learning and neuroplasticity as we could so each treatment session is designed to have two parts. First, there's a **Teaching phase** (called *pre-practice* in the motor learning literature) and second, **a Practice phase** (also called *practice* in the motor learning literature). These two components require different behaviours from both clinician and client.

The **Teaching phase** of each session looks like traditional speech-based therapy. The clinician uses any of the tools in their repertoire to teach the client what they need to do. The **Practice phase** of each session looks very different to traditional therapy and is the part that challenges most experienced clinicians.

Theoretical background

ReST is grounded in the current best evidence and theory in motor planning and programming (van der Merwe, 2009), Schema Theory (Schmidt, 1975), Principles of Motor Learning (Maas et al, 2008) and prosody and stimuli selection. Here is an overview of these theories.

CAS is believed to be a disorder of speech motor planning and programming (ASHA, 2007). This means the client knows what they want to say and can select appropriate words and sounds however the instructions on when and how to move their lips, tongue, jaw, soft palate and vocal folds in real time are degraded (van der Merwe, 2009). They can move their lips, tongue, jaw, soft palate and vocal folds accurately for example when eating, but have difficulty creating, modifying, evaluating, retrieving or storing motor instructions or plans and programs for speech.

According to Schema Theory (Schmidt, 1975 and subsequent) we store regular or learned movements such as sounds, syllables, words and phrases that are used frequently in General Motor Plans (GMP). These are "the idea" of the movement and not any given utterance. When we come to say a word, we take this and modify it by a range of movement "parameters". Parameters are the variations in the sequence, rate, range, or strength of movement. In speech, these parameters allow us to speak slower or faster, louder or softer and most importantly allow us to use co-articulation to make speech easier and more fluent. Parameterization also influences both sentence prosody and emotional prosody. Once we have applied the relevant parameters we have a Specific Motor Plan (SMP) which is the set of instructions sent to the muscles and includes all the timing instructions as well as the individual phones.

During and after the movement, we use our senses of touch, proprioception, muscle tension and hearing for feedforward and intrinsic feedback. Feedforward allows us to modify what is coming up. Feedback allows us to evaluate and store the GMP for use on another occasion. There is evidence which suggests breakdown in CAS in both feedforward and feedback mechanisms.

Once you have practiced a motor movement, and used your feedback mechanism you need to store the movement memory (in your brain, muscles do not have memories). We also currently believe that children with CAS may have trouble storing and/ or retrieving these movement memories.

The ReST treatment specifically uses nonsense words with varied stress (beats) and sounds so clients learn the instructions to say these words, but also to use these as a template to learn other words and fix existing real word productions. A major part of learning motor movements is adapting the General Motor Plan and the main way to do this is through practice – that is, learning to make these movements automatically. ReST meets this goal by implementing Principles of Motor Learning to ensure the capacity for learning movement is improved generally – not just for the nonsense words as part of the treatment. The nonsense words are a means to an end, helping us teach the CAS consensus-based core features. Therefore, data collection for ReST needs to include the treatment nonsense words but also generalization probes of real words.

ReST is designed to activate and use components of the speech motor system without reference to the broader language system (except, of course, phonology) by using nonsense words chosen for each client. We believe that by creating novel motor plans, practicing them frequently, and using both feedforward and feedback to improve the production of the target nonsense words we may be improving the client's capacity to use speech motor planning and programming effectively.

Disclaimers

While ReST has been shown to be effective in Australian English in three randomised control trials, in a single case experimental design study in American English, and in single case studies in Italian (Scarcella et al., 2019), Korean (Oh et al., 2021)and Portuguese (de Oliveira Silveira, 2021) it has not been independently tested in English or in an independent a randomised control trial and we do not know what the active ingredients in the therapy are. It may be that over time we will discover that only some of the program is required but for now, since we don't know which parts you can safely omit and retain a therapy effect, we recommend that you include all components of the treatment, regardless of your belief in their utility.

ReST therapy has been tested in research studies with children and young people with CAS and those with dysarthria from cerebral palsy. So far it has not been tested on its own with adults, or people with other kinds of dysarthria such as seen in Down Syndrome (although see Nakamura et al., 2024), or people with multiple diagnoses or syndromes although we are aware of clinical use of ReST with these populations. ReST therapy will not suit all clients. In the pilot phase, we treated two three-year-olds. This was unsuccessful. We have not yet researched using ReST with children with genetic conditions, intellectual disability or hearing impairment so clinicians should proceed cautiously, and ideally should collect the kind of session and progress data we report in the single case experimental design papers to ensure they know if they have treatment efficacy for the individual client.

The content of this manual differs from each of the research studies in several ways. Firstly, we have shown a number of variations have been effective and therefore these variations are included. Secondly, some of the things we did in the research were for research purposes rather than clinical ones; these have been omitted. We have however provided you with all the materials you will need to administer ReST as per the research so the client you are seeing can be expected to succeed. We have tried to assist with that by putting therapy cards, PowerPoint slides, data sheets and data collection ideas on the ReST website. www.rest.sydney.edu.au

This therapy is different to some usual speech pathology practice. The hardest part of treatment is giving cues and providing feedback for prosody (lexical stress), syllable segregation (smoothness) and articulation including mixed resonance simultaneously. It is possible you will need to update your transcription skills with diacritics and to practice listening to these aspects to provide successful treatment. The accompanying website (www.rest.sydney.edu.au) contains listening exercises to help with this revision. Clinicians should note each of the research studies speech pathology students were trained to deliver the treatment effectively and therefore we are confident that qualified clinicians can learn ReST therapy quickly and efficiently.

Finally, it is important to remember that a client with CAS or dysarthria associated with cerebral palsy may also, independently, or because of their CAS or cerebral palsy, have phonological or articulation errors, stuttering, or a voice disorder. These should be considered in goal setting in ReST and may need treatment before or after a block of ReST therapy specific to their other communication needs.

Client and Clinician Minimum Requirements.

ReST is designed to be used with clients who can produce a reasonable number of sounds and use CV[1] structured syllables. The minimum repertoire is 4 Consonants and 4 Vowels. We have used it successfully with children aged 4-15 but the younger children (especially 4-year-olds) need to be resilient, and all the successful 4-year-olds have had previous speech therapy. Most 5-year-olds who are attending school have no problems with the therapy. At the other end of the age range, older children and adolescents enjoy the treatment.

Clients need to be able to tolerate about 10 minutes of drill at a time and a 50–60-minute therapy session. Clients (and carers and clinicians) need to have some resilience or tolerance of failure and constructive criticism.

Clinicians also need to be able to follow a set program, be resilient to clients having limited success in the early stages of therapy and be able to resist the temptation to give feedback on every turn. It is important that clinicians are clear on setting expectations with families about how ReST works, the overall goal of the treatment, and what sessions will look like before they start ReST therapy.

We have created a ReST Readiness checklist which you can obtain from the website.

Service delivery models and therapy intensity.

ReST uses the principles of motor learning and neuroplasticity which means clients receive intensive therapy. In most of our studies, we have seen clients for 4 sessions per week for 3 weeks. When therapy is delivered this way, most clients have continued to improve with no extra therapy for up to 4 months following therapy.

We have researched less intense therapy consisting of 2 sessions per week for 6 weeks (Thomas et al., 2014). These clients made the same progress during treatment as those in the more intensive format BUT they didn't improve as much after therapy finished.

We've recently tested ReST as a one session per week for 12 weeks treatment and unfortunately this was not successful (Thomas et al., 2023). Only 1 of the 5 children showed substantial benefit. This is not surprising as the clients did not receive the intensity of therapy provided in the other studies and recommended for clients with CAS. **We do not recommend ReST therapy once per week.**

We have also tried training carers to do the therapy, but the treatment worked for fewer clients than clinician-delivered therapy (Thomas et al., 20. The carers weren't able to reliably judge prosodic accuracy and they felt uncomfortable being the 'therapist'. Not all carers were able to satisfactorily implement the therapy, and they felt worried about doing the therapy incorrectly. **We do NOT recommend carer delivery of ReST**, even as supplementary homework.

All studies with clients with CAS aimed to have a session length of about 1 hour, giving a total of 12 hours therapy. Some of the older clients were able to produce the 100 practice trials at word level in less than 45 minutes so these sessions were shorter but more intensive.

All studies were individual therapy. ReST is not recommended for group treatment as it has not been tested in that format. **No homework is required** regardless of whether you do therapy 2, 3 or 4 times per week.

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[1] CV = Consonant Vowel (as a syllable shape)

Currently we recommend that clients who complete an intensive block of ReST have a break from therapy or a break from speech work for a period of 4-6 weeks while the therapeutic effects are continuing. Clients who have the less intensive therapy are less likely to have the flow on effect and therefore may not need a break but, as yet we do not know how long ReST can be continued with ongoing effectiveness.

Therapy can be provided face-to-face or by telehealth and two clinicians can share provision of therapy both of which have been effective in some of our treatment studies. If clinicians are sharing the treatment, we recommend that they have a mutually accessible session record and data sheet that allows for easy handover of goals for the upcoming session.

A recent meta-analysis of ReST studies (Ng et al., 2022) showed that while all children in the included studies benefitted from their ReST therapy, the children who most benefitted, regardless of which service delivery model they received (3 weeks, 6 weeks, telehealth), were those who were older, had better overall speech accuracy but more vowel errors before treatment. SLPs and carers should consider this information in deciding whether to do ReST at this time for a given client.

How to do ReST therapy

How do I know where to start?

If in doubt, start at **three syllables** (See flowchart for outline). More precisely:

- **Start at three syllables**: If the client can produce at least ten different words with three syllables (albeit not 100% accurately), start at three syllables.
- **Two syllables**: For a client with fewer than 10 three syllable productions, start at two syllables.
- **For older clients** who only have problems with prosody and longer words, start at three syllables but be prepared to step up to Cloze sentences (more about this later) or four syllable items.
- **If you are choosing between 2 and 3 syllable words**, please consider:
  - o Temperament of the client. Some clients will have a go at the nonsense words without being overly concerned but others will not attempt the words if they are perceived to be difficult. Therefore, start the client on the level they will engage with the treatment.
  - o Setting them up for success. If you are unsure if they can do 2 or 3 syllables, starting on 2 syllables will allow them to learn what is expected in the treatment before stepping up to 3 syllable words. The 2 syllable words become a basis for the 3 syllable words, and 3 syllables for 4 syllable words and/or phrases.
  - o The accuracy of their 3 syllable words. Clients need to be able to produce at least 10 CVCVCV words to start on 3 syllable words (although they do not need to be perfect). Frequent sound (CV -> V) and syllable deletions may be best addressed in 2 syllable words initially.

Therapy goals

The goal of therapy is for the client to exactly match the clinician model of how to say the nonsense words. If the client can do this in the Practice Phase to 80% correct over 100 trials and over two consecutive sessions, then the client moves up to the next step in the hierarchy.

Within a session, if the client has done two practice blocks with less than 10% correct across the blocks, the clinician should do another teaching block and then resume with the next practice block. If the client achieves less than 10% correct in the learning phase of two consecutive sessions then you should step down. See flow charts for clinical decision making.
We have not established discharge criteria from the research as each client was only seen for 12 sessions regardless of severity.

ReST Goal Setting Flowchart

Does the client have CV structured syllables?

NO

YES

Not suitable for ReST at the moment.

Does the client have at least 4 syllable initial consonants and 4 vowels?

NO

YES

Start ReST therapy with two syllable nonsense words

Can the client produce at least 10 three syllable productions (words)?

NO

YES

Start therapy with three syllable nonsense words
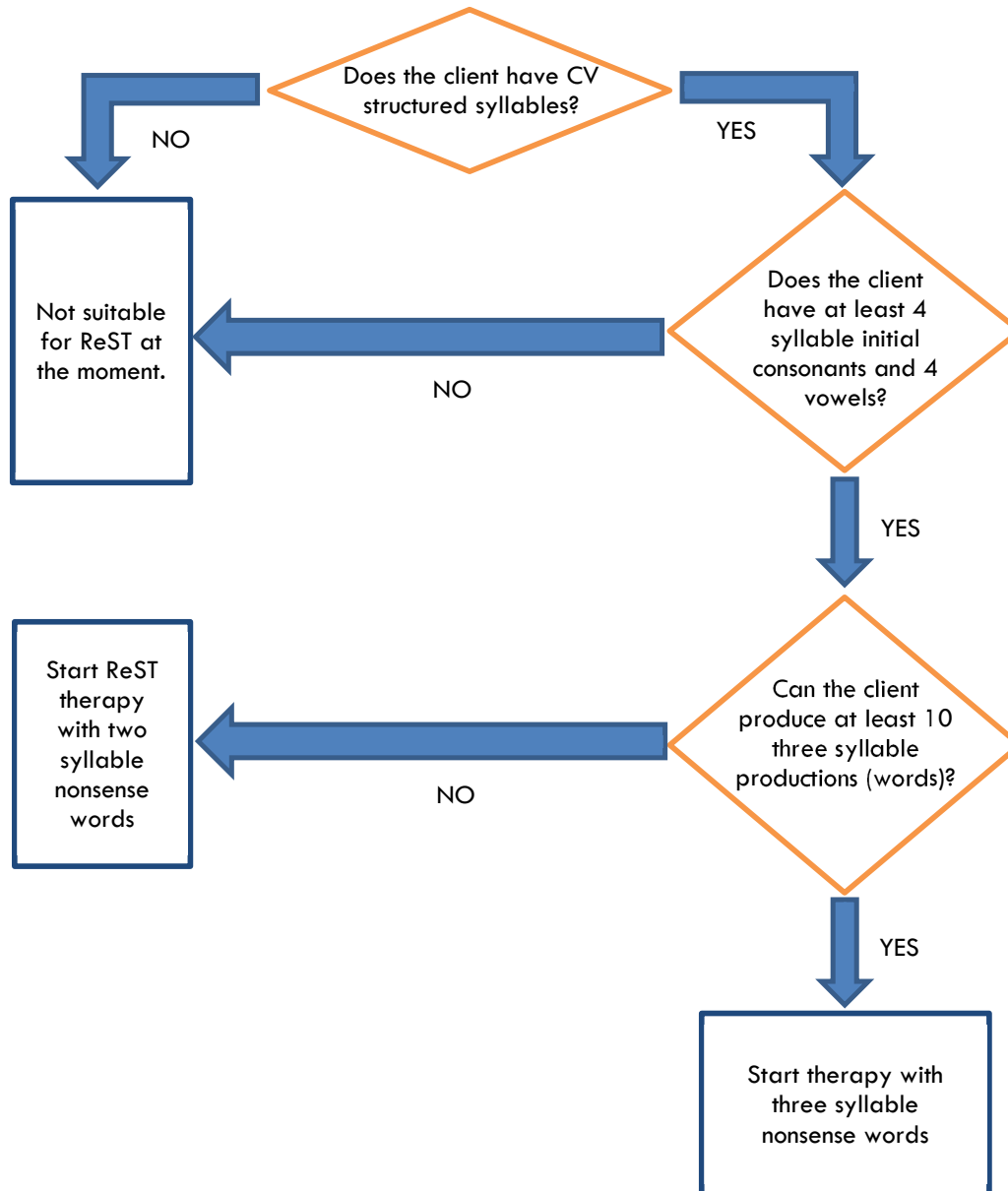
Example Goals

> **Basic goal:** [Name] will imitate 3 syllable nonsense words with simultaneously correct sounds, beats and smoothness in 80% of 100 trials in the practice phase.
>
> **Step up from the basic goal**: [Name] will imitate cloze phrases with a 3-syllable nonsense word with simultaneously correct <u>sounds, beats and smoothness</u> in 80% of 100 trials in the practice phase.
>
> **Step down from the basic goal 1:** [Name] will imitate 2 syllable nonsense words with simultaneously correct <u>sounds, beats and smoothness</u> in 80% of 100 trials in the practice phase.
>
> **Further step down 2:** [Name] will imitate 2 syllable nonsense words with two simultaneously correct elements (either sounds +beats, sounds + smoothness, or beats +smoothness) in 80% of 100 trials in the practice phase.

Preparation of Treatment Materials

Clinicians can:

a. use an existing list of nonsense words from our website as is, if it suits the client, (in English, Italian, Danish and Portuguese) or
b. adapt an existing list of nonsense words from our website by changing one or more consonants or vowels using a 'find and replace' command in Word, or
c. create their own materials (see below).

Target Selection

The English nonsense word sets focus on **4 consonants, 3 long vowels (or diphthongs) and schwa.**

Consonants:

The consonants should be in the client's inventory in **syllable initial position**.

The nonsense words have consonants that are **different** to each other – including at least **one voiced** and **one voiceless** phoneme. The nonsense words need at least 2 manner classes – e.g., plosives, fricatives/affricates, nasals or liquids.

An example of consonant combinations that were used in the research and have associated resources is /b, f, g, t/ (Murray et al, 2015). Another word set has other sounds (e.g., /m/ or /n/ for resonance and some short vowels as well as schwa to make the words as close to real words as possible). Sets of existing materials are available on the website (rest.sydney.edu.au).

Avoid later developing sounds (especially /r/) or any sounds if there is any concern about the client being able to articulate them accurately in CV syllables. Therefore, if you want to use an existing set of nonsense-words, replace the sound they cannot say without lots of assistance with one in the same manner class (e.g., swap 'f' for 's' so keeping a fricative).

Vowels: (English instructions)

1. Choose **three long vowels** from the client's repertoire.
2. Also select **one weak or neutral vowel (e.g., schwa).**
3. For some clients in the research, we selected **two long, one short and schwa.**
4. You can include **a diphthong** as one of the long vowels

Nonsense words

As described above, you have several options for a nonsense word set for each client. These are listed from easiest to hardest:

1. Use an existing set without modification, which are available at rest.sydney.edu.au
2. Use and existing set and modify it for your client
3. Use AI to make a set of words
4. **Make a new set by hand.**
   More details of each option follow. Whatever you do,

In 3 syllable nonsense words in English, the first weak syllable should always have a schwa and ideally the final syllable can have either a short production of a vowel such as /e/ or schwa.

If the client needs the two syllable words, then make them Sw and wS, leaving off the final syllable. In this case the weak syllable will always be a schwa. For example, for a Strong-weak (Sw) word would be/pɛːsə/ 'passeh' and a weak syllable (wS) word with the same consonants would be /pəsɛː/ 'pehsah'.

Check that you can easily say your words, and they are phototactically permissible. If not, you need to change them as needed.

1. Existing lists of nonsense words.
We have loaded a number of word lists on the website **rest.sydney.edu.au/resources**.

With the existing word lists you will find a range of resources that have been made for use in therapy including Word cards to print, PowerPoint lists of words, and session data sheets for the practice phase of each session. These resources were used in one or more of the research studies.

These lists will only be useful as is, if the entire set of consonants and vowels are appropriate targets for your client. Please use them cautiously. The words are phonotactically and phonemically allowable in Australian English so you may have to consider your own accent/dialect and modify either the spelling or the transcription.

NB in accents that use post-vocalic rhotic consonants and rhotic vowels, some of the words on the site will need adjustment to remove orthographic 'r' in the written words.

2. Modifying existing lists of nonsense words.
If you would like to modify the lists please use the 'replace all' function in Word or PowerPoint to ensure you don't miss any changes. You can replace a consonant or vowel sound as needed so that the words match the consonants you have selected for the client.

3. Use an AI tool such as ChatGPT to create nonsense words for you.
This is an emerging method. **Note:** We do not recommend this option if you have never done ReST therapy before – choose the first or second method above.

In our trial, the following instructions worked but you will need to carefully check that the AI has created a 10 SW(w) and 10 wS(w) words that are nonsense words in your dialect and you may need several instructions to correct any errors.

Insert your selected consonants in the instructions below and use this wording:

Please use the consonants ( ) and the vowels (a o e i) to create 20 3-syllable nonsense words that I can use for ReST Rapid Syllable transition treatment. Ten of the words must follow the pattern (stressed syllable- unstressed syllable - unstressed syllable) and ten must follow the pattern (unstressed syllable- stressed syllable - unstressed syllable). All syllables must have one vowel only.

We needed to add a second instruction:

These are great. Can you replace the final vowel in all the words with a 'schwa'

Using consonants /b t z k/, BING CHAT AI then created the following nonsense words indicating stressed with ':

Sww - Tábikə, Kózetə, Békitə, Zíbakə, Tézebə, Kátibə, Bókazə, Zébitə, Tíkobə, Kébatə

wSw - Tabíkə, Kozétə, Bekítə, Zabíkə, Tezébə, Katíbə, Bokázə, Zebítə, Tikóbə, Kebátə

We then edited them as follows to make the contrast clearer.

Sww – Ta:bɪkə, Kózetə, Békɪtə, Zí:bekə, Tézebə, Ka:tɪbə, Bókæzə, Zébɪtə, Tí:kobə, Kébætə

wSw - Təbíkə, Kəzétə, Bəkí:tə, Zəbí:kə, Təzébə, Kətí:bə, Bəka:zə, Zəbí:tə, Təkóbə, Kəba:tə

Finally, we turned them into orthographic equivalents

Sww – tahbikeh, kohzeteh, beekiteh, zeebikeh, teahzebeh, kahtibeh, bohkazeh, zebeteh, teekebeh, kehbateh

wSw - tehbeekeh, kezeete, behkeeteh, zebeekeh, tezeebeh, keteebeh, bekahzeh, zebeeteh, tekawbeh, kebahte

4. Making nonsense words by hand

Note: We do not recommend this option if you have never done ReST therapy before – choose the first or second method above.

a. Make nonsense syllables:

- Make syllables from the chosen consonants and vowels – each vowel and each consonant should be paired together.

For example:

Vowel	/p/	/s/	/d/	/k/
/ʉː/	/pʉː/	/sʉː/	/dʉː/	/kʉː/
/eː/	/peː/	/seː/	/deː/	/keː/
/iː/	/piː/	/siː/	/diː/	/kiː/
/ə/	/pə/	/sə/	/də/	/kə/

b. Combine the nonsense syllables into nonsense words:

- From the **nonsense syllables** you will need to **compile nonsense words** at the level of complexity suitable for the individual client. Create 10 words with the format of [Sww]- Strong syllable (long vowel), Weak syllable [schwa or short vowel], Weak syllable [schwa/short vowel] e.g., "pahsikeh"/peːsɪkə/

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- Create 10 words with the format of [wSw] -Weak syllable [schwa], Strong syllable (long vowel), Weak syllable [schwa/short vowel] e.g., "pesakeh" /pəsɐːkə/ or /pəsɐːkɐ/. NB: Vowel phonemes and consonants should not repeat in any individual nonsense word.

Spelling the nonsense words

In our research we have mostly used "orthographically biased" words. This means we have used typical spellings that are always only produced one way. Since you probably don't have access to the same database we used, we suggest that you use very clear spelling, and check with a few adults from the client's speech community for how they would say the nonsense words.

For example: "beedega" in Australian English is almost always said /bidəgɐ/ but it might be said as /bidəgaʳ/ in US English - this is why you will need to check each word for your own accent. Generally, in English, written double vowels are said as long vowels, but remember "book" and "moon" have the same vowel spelling and different vowel sounds in many accents.

Final therapy preparations
Practice saying the nonsense words

Write the words phonetically if that will help you produce them consistently. It is really important that your models of the words are consistent and "normal". By this we mean you must have a clear distinction between strong and weak syllables, normal speech rate and other prosody (relative syllable duration, pitch and volume). Say the words naturally. **Do not exaggerate or segment your productions in the models.**

Prepare therapy materials

Write all 20 words orthographically (normal writing) on PowerPoint slides, cards, or pieces of paper (check our resources online to see if we have done this for you).

When writing out the words, it's sometimes necessary to adjust the spelling. For example, the word 'pesake' could be read as pee – sake /pisæɪk/ (a two-syllable word), when it should be /pəsakə/. Therefore, you might change the spelling to 'pesakeh'.

Starting Therapy

Sample Session Plans

TIME	Sessions 1-2
0 - 0.05	Welcome, overview
0.05-0.25	Teaching
0.25-0.55	Practice including 1. 20 trials (2 minute game) 2. 20 trials (2 minute game) 3. 20 trials (2 minute game) 4. 20 trials
0.55	Summary, farewell

TIME	Sessions 3-12
0 - 0.05	Welcome, overview
0.05-0.15	Teaching
0.15-0.55	Practice including 1. 20 trials (2 minute game) 2. 20 trials (2 minute game) 3. 20 trials (2 minute game) 4. 20 trials (2 minute game) 5. 20 trials
0.55	Summary, farewell

Teaching Phase

The first part of the session is aimed at developing a **"minimal reference of correctness"** for the client, which means they gain an understanding of the task and have some early success. This phase corresponds to Prepractice in the motor learning literature. The steps for teaching the ReST concepts might include:

1. Explain to the client that they need to **exactly match the way the clinician says the word.**
2. Explain how to do that.
   a. Match all the sounds – say them the same way as the clinician
   b. Match the beats – get the stress pattern correct
   c. Match the smoothness – have all the syllables joined together the same way as the clinician
   NB: These three things need to happen ALL at once for the production to be correct but you can start by teaching them separately, and then combine them in the practice phase.
3. Randomly select words for teaching (in the first session) OR
   Choose words which were consistently incorrect in the previous session for the next teaching session.
4. Provide any/all cues to the client on how to get the production correct. This could include any of:
   a. Use modeling, visuals and explanations
   b. Ask for an attempt
   c. Provide "knowledge of performance" feedback – saying whether it was correct or not and why. For example, "*Great work, you said it really smoothly*" or "*Nice sounds but it was all bumpy, Let's try it again and get all the parts to join together*"
   d. Ask for self-evaluation
   e. Play back a recording for the client to listen to
   f. Break the three-syllable word into a 2-syllables + 1-syllable, build up accuracy and then combine them back into the 3-syllables. **Be careful not to model staccato or robotic (equal stress) at any time.**
   g. Some clients appear impulsive in their productions. They may perseverate on a production possibly because they cannot suppress the old motor plan. Use cueing and explanation to get the client to delay attempting the word for a few seconds, they don't need to start immediately and some kids benefit from a delay.
   h. Try simultaneous slow- or normal-speed productions
   i. Slow down to increase accuracy and then speed up. If you slow-down be careful to **retain the relative stress** patterns across syllables.
5. Repeat all of these steps as required **until the client has made 5 correct productions of ANY of the nonsense words** with whatever feedback or teaching is required (doesn't have to be spontaneous or consecutive productions).

This phase could take 20-30 minutes in sessions 1 and 2 but should be restricted to no more than 10 minutes in all subsequent sessions. If you've done 10 minutes in subsequent sessions but the client still hasn't achieved 5 correct productions with lots of cueing, you may need to step down to two syllable nonsense words and start from there.

Teaching the concepts of Sounds, Beats and Smooth.

Depending on the age of the client, we use:

- the written words Sounds, Beats, Smooth
- wooden blocks/magnetic strips of varying length to indicate long and short syllables
- paper and pen to draw long and short, write letters, explain with pictures

- a drum for loud and soft beats
- a toy train with two carriages that attach or chain links to teach smoothness
- pictures which the client already associates with individual sounds
- dolls or pictures of people/animals that can be made to hold hands (smoothness)

Practice Phase

This is the most important part of the treatment.

This section is designed around those principles of motor learning known to facilitate long term change in motor skills.

Do not be tempted to spend more time on teaching and less on practice as you will not get the same results. For an overview of the principles of motor learning, please see Maas et al., (2008).

Practice happens in 20 trial drill blocks, with a 2 minute non therapy game between blocks to reward the client and provide a very short break from the intense practice. The games can be anything you will both enjoy, such as trash bin basketball, Jenga, or tic-tac-toe, but should not be focused on speech, language or literacy (e.g., not Scrabble).

Remind the client that they need to get the Sounds, Beats and Smoothness correct all at once to be correct. Explain that you will tell them when they get it right or wrong but won't be able to help them fix it. Let them know that you won't provide feedback on every trial. Ask them to listen carefully and to only try to say the word when they are ready.

The PowerPoint files and data sheets on the website have the words randomly presented. Present the first card or PowerPoint slide and say the word to the client. Ask the client to copy you. Listen to the client's production and check whether the client matched (or did not match) your production. In order to be a match, the word needs the same sounds, the same stress pattern and the same smoothness as the model.

Phonemically transcribe the client's response – this gives you a delay before you give feedback. You should wait for at least 3 seconds before you give feedback. Delayed feedback is a principle of motor learning and is known to facilitate storage of the correct production and self-evaluation.

You are aiming for 100 of these productions every session. You should present 20 randomly selected words in a block and then have your short break.

Older clients (adolescents and adults) may choose to do 4 blocks of 25 trials rather than 5 blocks of 20 trials. Some children who have trouble transitioning between practice blocks and game breaks could also benefit from longer blocks of trials (40 trials per block) and longer game breaks.

If you do not get all 100 trials done in one session (which might happen in sessions 1 and 2 or if you step up to sentences), save those items and try to add them onto later sessions to help ensure the client gets the entire dose of 1200 practice trials.

A treatment session flow chart shows the flow from beginning to end of the session on the next page.

Treatment Session Flowchart

```
                                    ┌─────────┐
                                    │  Start  │
                                    └─────────┘
                                         │
                                         ▼
                          ┌──────────────────────────┐
              No          │        Teaching          │ ◄──────────────┐
         ┌────────────────►└──────────────────────────┘                │
         │                            │                                 │
         │                            ▼                                 │
   ┌───────────────┐     No    ┌───────────────┐                       │
   │ Has 20 minutes│◄──────────│  Were 5 words │                       │
   │   elapsed?    │           │    correct?   │                       │
   └───────────────┘           └───────────────┘                       │
         │ Yes                        │ Yes                             │
         │                            ▼                                 │
         │                 ┌──────────────────────┐                    │
         └────────────────►│ Practice – 20 words +│                    │
                           │   2-minute game      │                    │
                           └──────────────────────┘                    │
                                      │                                 │
                                      ▼                                 │
                           ┌──────────────────────┐                    │
                           │ Practice - 20 words +│                    │
                           │    2 min. game       │                    │
                           └──────────────────────┘                    │
                                      │                                 │
                                      ▼                                 │
                           ┌──────────────────────┐     No             │
                           │  Were 4 or more      │────────────────────┘
                           │ of last 40 correct?  │
                           └──────────────────────┘
                                      │ Yes
                                      ▼
                           ┌──────────────────────┐
                           │ Practice - 20 words +│
                           │    2 min. game       │
                           └──────────────────────┘
                                      │
                                      ▼
                           ┌──────────────────┐   Yes    ┌──────┐
                           │  Has the session │─────────►│ STOP │
                           │  lasted 60 min.? │          └──────┘
                           └──────────────────┘
                                      │ No
                                      ▼
                           ┌──────────────────────┐  Yes   ┌──────┐
                           │ Practice 20 words +  │───────►│ STOP │
                           │    2 min. game       │        └──────┘
                           └──────────────────────┘
                                      │
                                      ▼
                           ┌──────────────────┐
                           │  Has the session │
                           │  lasted 60 min.? │
                           └──────────────────┘
                                      │ No
                                      ▼
                           ┌──────────────────────┐  Yes   ┌──────┐
                           │ Practice 20 words +  │───────►│ STOP │
                           │    2 min. game       │        └──────┘
                           └──────────────────────┘
```
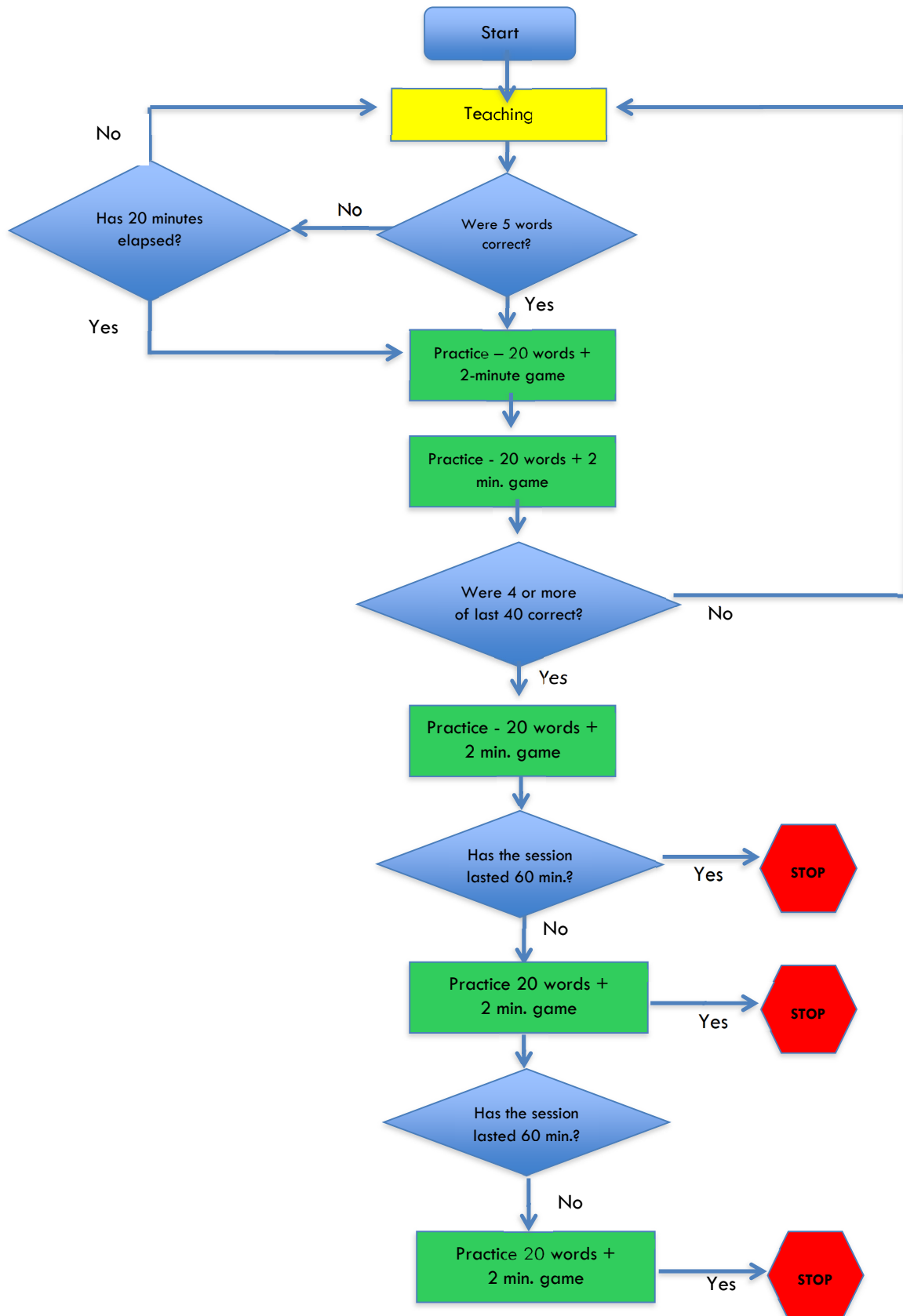
Providing Feedback to the client

Knowledge of Results Feedback

Give feedback on whether the client said the word the same as you (correct) or differently (incorrect). Do not tell them how to fix it. This type of feedback is called *"Knowledge of Results"*. For example, *"Great work", "Not that time"*. This is the opposite of what many people are told to do as beginning speech pathologists, because it is deliberately not specific. It is important to give Knowledge of Results feedback because it facilitates the client making self-directed changes to their speech.

You can also give summative feedback, such as "in that block you got 10/20 right. This is particularly useful for older clients. Many clients like to try to beat their "personal best" or "game high" both for each block and for sessions as a whole.

Rate of Feedback

Give feedback on a randomly selected 50% of the items in the practice phase. The asterisks on the data sheet indicate which items to provide feedback. The asterisks have been randomly allocated to items in the following manner:
- On the first block of 20, feedback for a random 18/20 attempts.
- On the next block, feedback for 14/20 attempts.
- On the third block, feedback for 10/20
- On the fourth block, feedback for 6/20
- and on the final block, feedback for 2/20 attempts.

This gives you random feedback on 50% of attempts. Random, low-frequency feedback results in better retention than feedback on 100% of items. It is useful to set out your data sheet with asterisks on the items you will give feedback on, so you are not counting or choosing in the middle of practice blocks.

Phrase level step up.

As mentioned above, clients who can accurately say the 3 syllable nonsense words to 80% correct over 2 consecutive sessions should be stepped up to Cloze sentences (carrier phrases). You need 10 of these and they should also be randomized along with the randomized presentation of words. This is harder not only because the client must get all aspects of the word correct, but because **they need to say the whole sentence as a match** to your production on sounds, beats and smoothness. Make sure you let the client know that they are "levelling up" and this will mean it is harder but it will get easier over time.

Below are the sentences we have previously used. You will notice that the target word is always treated as a noun and is always put in the final word position.

1.   I saw a _____!
2.   I want a _____
3.   She has a big _____
4.   I went to the _____
5.   Where's the _____?
6.   He gave me a _____
7.   It's his _____
8.   There's a _____
9.   Can I have a _____?
10.   Here's the new _____!

Anything formatted as a question needs to be said as a question (rising terminal pitch) and if it's a statement it needs statement prosody. This varied prosody is an additional level of complexity. Make sure you check that all sounds in the carrier phrase are in the client's inventory.

If the client gets 80% correct on the phrases you can make them more complex by including two nonsense words. Here is an example of such a sentence:

I saw a _____ and a _____

Judging correct and incorrect productions/ Teaching the components

Each attempt at a nonsense word needs to be evaluated for whether the sounds, beats and smoothness are correct. In the Practice phase, all need to be correct at once and across the whole word for the client to score as correct.

Sounds: These are the consonants and vowels. Sounds must match the clinician model, that is, if a client produced a distorted 'f' sound, their 'sounds' would be incorrect. We are aiming for accurate and consistent production of all phonemes, including appropriate resonance.
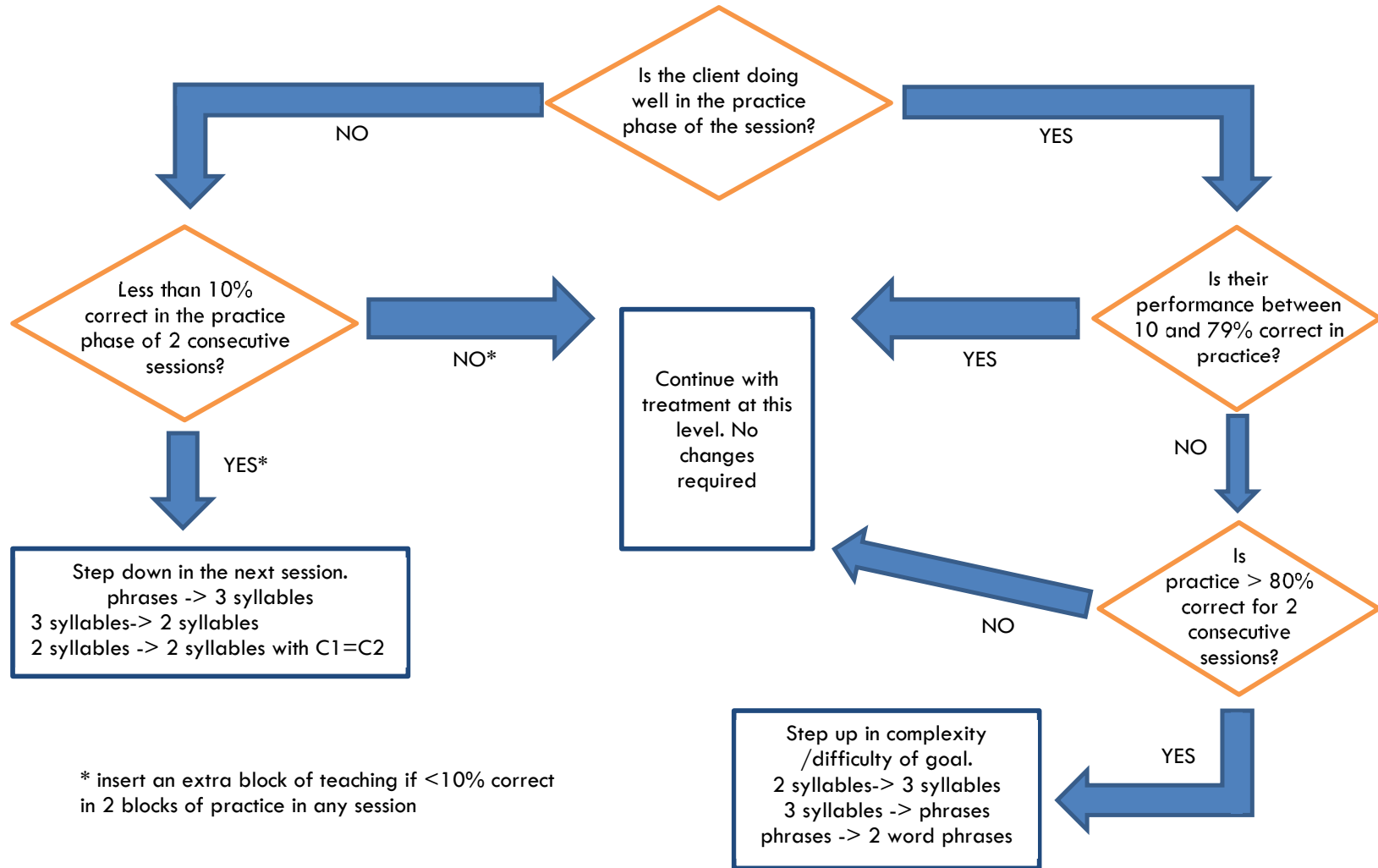
Beats: This is the relative stress between syllables, which again must match the clinician model. To make stressed syllables in English we lengthen the vowel, increase the volume of the syllable, or raise the pitch of the syllable. Clients may benefit from cueing in the Teaching phase on any of these features but we have found the easiest to be length (duration) and the hardest to be pitch (frequency). When choosing a cue for beats, start with making the syllable longer or shorter. If this is unsuccessful over several sessions, cue for louder or softer and finally cue for a change in pitch. Any production that sounds robotic, very slow, or has equal stress, is wrong. Younger clients are likely to have more trouble with the wS(w) words than the Sw(w) words, so this may require specific attention in the next Teaching phase. Strong beats are in bold on the pronunciation guide for existing word sets.

Smoothness: This is the hardest to judge and requires that the syllables are continuous with each other. Of course, if you have a stop consonant there will be a slight pause between syllables but again, the client's production needs to match the clinician's production. Any production that sounds stilted or staccato is wrong.

If you have any doubt about whether the production was correct or not then you SHOULD SCORE IT AS INCORRECT

A therapy progress flow chart shows progression through the goal hierarchy on the next page.

Therapy progress

Is the client doing well in the practice phase of the session?

NO

YES

Less than 10% correct in the practice phase of 2 consecutive sessions?

NO*

Continue with treatment at this level. No changes required

YES

Is their performance between 10 and 79% correct in practice?

YES*

NO

Step down in the next session.
phrases -> 3 syllables
3 syllables-> 2 syllables
2 syllables -> 2 syllables with C1=C2

NO

Is practice > 80% correct for 2 consecutive sessions?

YES

* insert an extra block of teaching if <10% correct in 2 blocks of practice in any session

Step up in complexity /difficulty of goal.
2 syllables-> 3 syllables
3 syllables -> phrases
phrases -> 2 word phrases

Keeping track of progress

There are 2 main questions to answer when you are completing treatment for a client.

The first is, is the treatment working and are the cues making the client's productions change? According to Olswang and Bain (2011), this is answered by your treatment session data. The data sheets found with the existing words can help you answer if the client's productions are (1) becoming more accurate in Teaching and which cues helped and (2) if they are becoming more accurate in Practice over time, meaning they are learning how to say nonsense words with simultaneously correct sounds, beats and smoothness.

The second is, is the treatment changing the client's planning and programming of other real words? This is what caregivers are most keen to see and need to be measured. According to Olswang and Bain (2011), this is answered by generalization data. This needs to be planned before treatment starts, so similar 2 and 3 syllable words alone and in phrases are probed before treatment, at the start of session 4, session 8 and session 12 to show progress.

Examples of generalization probes we have used are on the resources page – [http://rest.sydney.edu.au/resources.shtml]. In addition, you may want to assess intelligibility and other speech areas of interest for your client before and after treatment. For example, we have used inconsistency subtests and articulation tests for this purpose. You might also consider a participation measure such as the Intelligibility in Context Scale (ICS; McLeod, Harrison, & McCormack 2012) which is freely available from https://www.csu.edu.au/research/multilingual-speech/ics

Adapting ReST for languages other than English

ReST has now been shown to be effective in a number of languages other than English however it isn't a straight swap from one language to another. Before trialing ReST in a language other than English you will need to make sure you understand the how polysyllabic words are made and how stress is indicated in your language.

For example, in Italian, the most common stress pattern in 3 syllable words is wSw, the second most common is wwS and Sww is the least common so we added a third stress pattern (wwS) when we tested ReST in Italian. Similarly, in Turkish, stress is not indicated by duration as in English but by pitch and volume.

Please check the ReST website for materials in a range of languages including Italian and Danish and email Tricia McCabe if you would like some help adjusting ReST to a new language.

Adapting ReST for children and young people with cerebral palsy

ReST has now been shown to be effective in children and young people with cerebral palsy and dysarthria (Korkalainen et al 2022; 2023). In the 2023 study all the therapy was provided via telehealth, while in the 2022 study the therapy was provided face-to-face. The changes we made to accommodate fatigue associated with cerebral palsy were as follows: In both studies we provided therapy three times per week for six weeks for 45 minutes and included longer between blocks breaks if the client required it due to fatigue.

Frequently asked questions

What if I'm not sure whether the word was correct or incorrect?

If you're not sure, you should tell the client the word was incorrect (if the trial is supposed to have feedback).

What if I finish the work sooner than an hour?

That's no problem! If the client gets through the Teaching phase followed by 100 practice trials quicker than an hour, that's fine.

What if the client really can't do one of the words in the Teaching phase?

That's OK. If they can't say the word you should move on to another word. Keep the 'tricky' word in the set, use it in Practice, and try teaching it in the next Teaching block. It's OK to acknowledge that it is tricky and to tell the client you will help them with it at the start of the next session.

What if the client restarts and the second attempt is correct?

The word is counted as incorrect. Remind the client to wait until they are ready to start the word. This might be something to focus on in the next Teaching phase.

What if the client gets stuck on a word or a particular production and can't change it?

In the next Teaching phase, try teaching the client to practice the word in their head (silently and without moving their lips) before they say it. You could also ask the client to wait for a couple of seconds after they hear the word before they make an attempt. We use 'think then say' cues for this.

Can the client just read the word without hearing my model?

Many clients with CAS also have difficulties reading aloud. We suggest that no clients read aloud spontaneously for the first three sessions. If they are excellent readers, they can read the items from the fourth session. We don't want speech errors to be because of reading difficulties. If you are allowing clients to read the words, you may also want to spend some time in the teaching phase helping them understand how to read the nonsense words – especially knowing where the schwas are as they are written differently when spelt.

What if the client is getting very few right in Practice?

Its common in the first few sessions for clients to get less than 20% correct so we acknowledge that it is new and might be difficult but we are going to help them learn to say the word. If the client gets fewer than 4/40 correct in the first two blocks of practice, you can insert another block of Teaching and then go on to the next 40 practice trials.

What if the client can only say the words very slowly or very softly?

The word is incorrect. In the next Teaching phase teach the client say the item quicker or louder. You can adjust your models to be quicker and louder to model this behaviour. Just before the start of the next block of Practice, remind the client that they need to do it at the same speed and/or volume as the model. Make sure you are not modelling it slower than normal speaking pace.

Can I include articulation therapy to correct poor sound production?

We would suggest that you do not include sounds that the client has a consistent articulation error on but sometimes it is unavoidable.

If you need to do incidental articulation therapy please limit it to the Teaching phase. Please note that working on a consistent articulation error within ReST might mean more time is given to this error and gains in sequencing and prosody may not be as good. Instead, working on the consistent articulation error or non-stimulable sound in another block of therapy using an evidence-based approach may be more effective from our clinical data and experience. We have not tested this in a trial.

Can I provide ReST to clients who have CAS and a stutter?

Yes you can. A few of the clients in the research had a stutter and their fluency improved after ReST treatment. We don't know if the stutter was a separate issue or part of their CAS, and we cannot be sure that it was the ReST therapy that caused the change to their fluency so please be careful in how you describe it to carers. Importantly their speech improved. Fluency errors or stuttering count under the smoothness label in ReST treatment.

Some clients with CAS have resonance problems, can we treat this in ReST?

Yes. The Murray et al., (2015) stimuli words deliberately have a /m/ and /n/ so you can teach oral versus nasal resonance as part of the therapy. You can add more nasal targets in the nonsense words you use to make this a major goal. Ideally, you would want some oral-only words as part of this.

Resonance can be taught in the Teaching blocks. You can teach oral versus nasal resonance, link this with the written sounds and help the client feel the difference between oral and nasal airflow (e.g., feeling where the air comes out using their hand or a tissue). Resonance errors in ReST are considered sound errors on your data sheet.

Lots of clients with CAS have prosodic problems, can we treat this in ReST?

Yes, ReST specifically treats prosody as a major goal of therapy. All the treatment words address lexical stress – that is alternate stress across syllables in words. When you select treatment targets, you need 20 words: 10 will have strong-weak lexical stress and the other 10 weak-strong lexical stress. As a clinician giving models, you need to be clear on what lexical stress your treatment words have and know how to say these accurately and consistently.

Clients with CAS tend to make weak syllables strong or to delete weak syllables, so that stress across a word or phrase is all strong. The teaching phase should help clients understand they need weak syllables also. Strong syllables are those that are longer, louder or higher pitched than those around it. Therefore, you can teach clients to make weak syllables 'short', 'soft' or 'deep' depending on their needs. Prosodic errors in ReST are considered beat errors on your data sheet. This means the beats of each syllable (their stress) did or did not match the model.

This is really hard. Typically developing children couldn't do it either!

We tested ReST on typically developing children aged 4-12 and they learnt how to say the words in 3-5 sessions. So far none of the children with CAS have had normal speech after a short block of ReST but all have improved substantially.

Can you provide me with a premade list of words?

Yes, but it is important for each client to use words which include sounds in their own speech inventory. You can use the lists on the website but please make sure the client can use the sounds in the lists or

modify the lists. If you make new word lists, we'd love it if you email us the list and any supporting materials so we can add them to the site!

Can I use clusters in the stimuli?

Yes. Some of the older/ milder children in the research had nonsense words with clusters in word initial and word medial position (although it is likely that the medial clusters do not work as true clusters phonologically in medial position).

The TEMPO paper (Miller et al.,2021) is slightly different to the ReST papers, is this important?

The TEMPO paper uses 4-syllable nonsense words over 16 sessions in 4 weeks. So it's more therapy but the nonsense words are more difficult. You can choose more difficult words if you wish – we anticipate that some children will find this very difficult and others will be appropriately challenged. Our recommendation is to consider using 4-syllable words as a step up from 3-syllable words if you would prefer not to use Cloze sentences as the step-up however since we have not done a direct comparison we leave it to your clinical judgment as to what will be best for your client.

How do you keep children engaged in drill treatment without pictures?

Using a visual timetable is really helpful. Show the client how many blocks of Teaching and Practice they need to do. Other things we've found helpful are counting down how many items are left in a block (using counters, a number chart or gatepost counting with the client), praising the client for their attention, and, for children, having a range of games for the client to choose from in the break time. The games can be anything that motivates the client, including active games such as star jumps and running races. School aged children respond really well to "gamification" – use the language of video games – "personal best", "game high" or "high score". Older clients respond well to being shown the changes in their scores from day to day and beating their own best score. They also love "levelling up" and understand that the new level will be harder.

Early on we had pictures of aliens matched with the nonsense words. However, learning 20 of them was too much to ask, so we were left with reading the words or imitating a spoken or recorded model.

Do you think that treatment effects might generalize better if you used real words rather than nonsense words?

The whole point of ReST is to avoid real linguistic forms – we believe ReST is associated with good generalisation BECAUSE the semantic system is not engaged in the nonsense words – the client is compiling a new and unexpected motor plan without the assistance or interference of the semantic system. No already learnt incorrect productions need to be corrected in the nonsense words. The phrases are real phrases except for the nonsense word(s). If you are interested in this topic, you could read the treatment journal articles on both ReST and on generalization of nonsense words to real words in other speech sound disorder treatment also (Gierut & Morrisette, 2010).

Is the goal of ReST only to teach prosodic variation, or can it include work on speech sound accuracy?

The goal of ReST is to address the three core features of CAS simultaneously. While it is a great treatment for prosody, it also works on sequencing of sounds and the production of the specific sounds selected in the nonsense words. If a sound (or sound class) needs attention, select it as one of the phonemes in the nonsense words. Ideally however, the sound you choose should be stimulable (produced accurately some of the time) otherwise it is difficult to treat all 3 aspects simultaneously.

If a client has two sessions of treatment but is then away for a week, does the program have to start afresh or pick up from where it left off?

It's best to schedule one block of ReST at a time when the child and carer can commit to regular intense treatment. School holidays are a good time for many school-aged clients. Even with the best planning, unforeseeable events and illnesses sometimes happen. If a client has missed several sessions in a week they are likely to need longer in the Teaching phase of the next session in order to re-orientate them to the treatment and potentially a longer therapy block.

What instructions should carers be given about practice at home?

We have tried training carers to do therapy with limited success. Carers found the treatment difficult to do and felt that making the prosodic judgments was too hard. Most carers are immensely relieved about not having to do homework and value the opportunity just to be carers for a while.

In all the other research, we have achieved very good results **without** any carer/home practice, so there is no need for them to do it.

Do we need to complete 20 words in every block of Practice? What if my client can do more than that?

20 words per block of practice is a minimum. For older clients you can increase the number of trials to 25 (we did this in the research) or up to 40 words per block (as per our clinical experience). This then reduces the number of blocks (and breaks) to four, which may make the session slightly faster. You need to ensure that accuracy does not decrease if you increase the number of trials per block. If so, decrease it again to a number that allows the client to concentrate and produce the trials effectively.

Can I use ReST with clients with comorbidities such as Down Syndrome?

Clinically, we know of a number of children and young people with Down Syndrome who have benefitted from ReST therapy. Some of these people may have had CAS while others would have had dysarthria. It will be important to tell carers that what you are doing is experimental and you will monitor it closely to make sure their child is benefitting. Monitoring progress carefully includes collecting daily treatment data and regular probes to see if generalisation is occurring. A recent study (Nakamura-Palacios et al 2024) reported a successful trial of ReST alongside brain stimulation with an adult with Down Syndrome.

Can I use ReST with adults with apraxia?

We have trialled ReST clinically with adults and found that it works however we do not yet have any research evidence to support recommending this to you (we are planning to collect it, so check with the website). If you and your client go ahead and trial ReST, please monitor it closely to make sure your client is benefitting. Monitoring progress carefully includes collecting daily treatment data and regular probes to see if generalisation is occurring.

Can I work on ReST at the same time as another treatment?

All of our studies show exclusive use of ReST for the block has been beneficial. We would recommend working on the other goals in separate treatment blocks around the ReST treatment block, not concurrently. Doing extra things in your session could affect the treatment intensity and learning and therefore the outcome of therapy.

How do I know if my client responded to ReST as expected?

Each client's response pattern may vary, with some taking a number of sessions to show significant improvement. In the tutorial paper (McCabe et al., 2020; open access) we describe several different patterns of success. If you are concerned about progress after a few sessions, it may be worth having a read.

On average, clients in the ReST studies achieved a 40% increase on their accuracy of treated words or phrases (where everything was correct, sounds, beats and smoothness). This can be determined looking at their treated items in probes or their first session to last session treatment data results.

I can only see the client once a week for 30 minutes!

The principles of motor learning and all the ReST and other CAS treatment research suggests that twice per week is the minimum amount of therapy that will be successful, we DO NOT recommend once per week or only 30 minutes of therapy per week based on recent evidence (Thomas et al, 2023) Remember that in a complete session of ReST, the clinician needs to complete the teaching phase as well as 100 practice trials. This is hard to achieve in a 30-minute period.

Some suggestions on how to get around this problem:

- negotiate with the funder, your employer and the client's family to save up the 30 minutes per week so that the client can have a more intensive therapy block followed by a break or generalisation. A break is supported by the research evidence and allows the changes made in ReST therapy to consolidate.

- consider taking on a student SLP to do the ReST therapy – as part of a placement or as an SLP-A.

- if it is your time or schedule that is limited, consider sharing care with another SLP or providing one session per week face-to-face and one by telehealth.

How many blocks of ReST can/should I do with a client?

None of the clients in the research have been in repeated or multiple blocks of ReST therapy so from the research evidence we do not know how many times you can provide it and still have speech improvements. Clinically we know that clients can continue to improve over 2-3 blocks spread over a year.

If I do a second block, do I use the same words again?

Clinically, we have always used 20 **new** nonsense words for each new block of sessions. This is because we want to continue to challenge the client's speech motor planning system. We always change at least some of the consonants with a new block.

Where do we start if we do another block of ReST?

This decision will be up to your clinical judgement. For clients who stepped up from 2- to 3-syllable words or from 3-syllable words to cloze sentences, we recommend dropping back down to the previous level at the start of the next block. It is likely that your client will find the new words more difficult than the old ones and dropping down will give them some initial success. Our clinical experience is that they will move up to the higher level quite quickly.

Research Articles about ReST

(as at 1st January 2024)

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. doi:10.1044/1092-4388(2010/09-0130

de Oliveira Silveira, B. (2021). Translation and cultural and linguistic adaptation of the therapeutic intervention method ReST- Rapid Syllable Transition Treatment into Brazilian Portuguese. Unpublished thesis (Graduate in Speech Therapy) - Federal University of Santa Catarina. Brazil.

Korkalainen, M. J., McCabe, P., Smidt, A., & Morgan, C. (2022). Outcomes of a novel single case study incorporating Rapid Syllable Transition treatment, AAC and blended intervention in children with cerebral palsy: a pilot study. *Disability and Rehabilitation: Assistive Technology*, 1-10. https://doi.org/10.1080/17483107.2022.2071488

Korkalainen, M. J., McCabe, P., Smidt, A., & Morgan, C. (2023). The effectiveness of Rapid Syllable Transition Treatment in improving communication in children with cerebral palsy: A randomized controlled trial. *Developmental Neurorehabilitation*. *https://doi.org/10.1080/17518423.2023.2218485*

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. doi: 10.3109/17518423.2014.906002.

McCabe, P., Preston, J. L., Evans, P., & Heard, R. (2023). A Pilot Randomized Control Trial of Motor-Based Treatments for Childhood Apraxia of Speech: Rapid Syllable Transition Treatment and Ultrasound Biofeedback. *American Journal of Speech-Language Pathology, 32*(2), 629-644. https://doi.org/10.1044/2022_AJSLP-22-00144 (OPEN ACCESS).

McCabe, P., Thomas, D. & Murray, E., (2020). Tutorial: Rapid Syllable Transition Treatment (ReST) - A treatment for Childhood Apraxia of Speech and other pediatric motor speech disorders. *Perspectives of the ASHA Special Interest Groups. 5* (4) https://doi.org/10.1044/2020_PERSP-19-00165 (OPEN ACCESS).

Miller, H. E., Ballard, K. J., Campbell, J., Smith, M., Plante, A. S., Aytur, S. A., & Robin, D. A. (2021). Improvements in speech of children with apraxia: The efficacy of Treatment for Establishing Motor Program Organization (TEMPOSM). *Developmental Neurorehabilitation, 24*(7), 494-509. https://doi.org/10.1080/17518423.2021.1916113

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*, 112. doi: 10.1186/1471-2431-12-112. (OPEN ACCESS).

Murray, E., McCabe, P. & Ballard, K.J. (2015). A Randomized Control Trial of Treatments for Childhood Apraxia of Speech. *Journal of Speech, Language and Hearing Research 58* (3) 669-686. doi:10.1044/2015_JSLHR-S-13-0179.

Nakamura-Palacios, E. M., Falçoni Júnior, A. T., Tanese, G. L., Vogeley, A. C. E., & Namasivayam, A. K. (2024). Enhancing Speech Rehabilitation in a Young Adult with Trisomy 21: Integrating Transcranial Direct Current Stimulation (tDCS) with Rapid Syllable Transition Training for Apraxia of Speech. Brain Sciences, 14(1), 58. https://doi.org/10.3390/brainsci14010058 (OPEN ACCESS)

Oh, D. H., & Ha, J. W. (2021). Development and clinical application of Korean-version nonword intervention to improve speech motor programming. *Phonetics and Speech Sciences, 13*(2), 77-90. https://doi.org/10.13064/KSSS.2021.13.2.077

Ostergaard, G. (2021). "Så kan jeg bedre kontrollere det med min hjerne, så det ikke kun er munden, der siger det" [Translation from Danish: Then I can better control it with my brain, so it's not just the mouth that says it] *Dansk Audiolopædi 3*, 15-20. https://issuu.com/danskaudiologopaedi/docs/dansk_audiologop_di_3_2021

Ng, W. L., McCabe, P., Heard, R., Park, V., Murray, E., & Thomas, D. (2022). Predicting Treatment Outcomes in Rapid Syllable Transition Treatment: An Individual Participant Data Meta-Analysis. *Journal of Speech, Language, and Hearing Research, 65*(5), 1784-1799. https://doi.org/1784-1799. 10.1044/2022_JSLHR-21-00617

Scarcella, I, Michelazzo, L. & McCabe, P. (2021). A Pilot Single-Case Experimental Design of Rapid Syllable Transition Treatment for Italian Children with Childhood Apraxia of Speech. *American Journal of Speech Language Pathology.* https://doi.org/10.1044/2021_AJSLP-20-00133

Thomas D, McCabe P & Ballard KJ. (2014) Rapid Syllable Transitions (ReST) Treatment for Childhood Apraxia of Speech: The Effect of Lower Dose Frequency. *Journal of Communication Disorders 51*: 29-42. https://doi.org/10.1016/j.jcomdis.2014.06.004

Thomas, D., 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* Doi: 10.1111/1460-6984.12238.

Thomas, D. C., McCabe, P., Ballard, K. J., & Bricker-Katz, G. (2018). Parent experiences of variations in service delivery of Rapid Syllable Transition (ReST) treatment for childhood apraxia of speech. *Developmental Neurorehabilitation, 21*(6), 391-401. https://doi.org/10.1080/17518423.2017.1323971

Thomas D. C., Murray, E., Williamson, E. & McCabe, P. (2023). Weekly Treatment for CAS with Rapid Syllable Transition Treatment (ReST). A single case experimental design (SCED) study. *Journal of Speech Language and Hearing Research.* https://doi.org/10.1044/2023_JSLHR-22-00665

van Rees, L. J., Ballard, K. J., McCabe, P., Macdonald-D'Silva, A. G., & Arciuli, J. (2012). Training Production of Lexical Stress in Typically Developing Children with Orthographically Biased Stimuli and Principles of Motor Learning. *American Journal of Speech-Language Pathology*, doi: 1058-0360_2012_1011-0008.

Other references

ASHA. (2007). *Childhood Apraxia of Speech* [Position Statement]. www.asha.org/policy.

Maas, E., Robin, D. A., Austermann Hula, S. N., Freedman, S. E., Wulf, G., Ballard, K. J., & Schmidt, R. A. (2008). Principles of motor learning in treatment of motor speech disorders. *American Journal of Speech-Language Pathology, 17*(3), 277-298. doi: 10.1044/1058-0360(2008/025)

Schmidt, R.A. (1975). A schema theory of discrete motor skill learning. *Psychological review, 82* (4), 225. Doi: 10.1037/h0076770

Glossary

Term	Definition
ASHA	America Speech-Language Hearing Association
Beats	Term used to explain lexical stress (i.e., the relative stress pattern between syllables within a word)
CAS	Childhood Apraxia of Speech
CV	Consonant Vowel (syllable shape)
Dyspraxia	Dyspraxia or Developmental Verbal Dyspraxia is another name for CAS
Internal reference of correctness	An understanding of how a movement should happen. It is thought to require a performance of a successful movement to acquire an internal reference of correctness.
KP	Knowledge of Performance feedback (i.e., information about what was right and what was wrong about an attempt, and may include instructions about how to improve the attempt
KR	Knowledge of Results feedback (i.e., whether the production was right or wrong)
Lexical stress	The relative stress pattern between syllables within a word. Syllables which are relatively longer, louder and/or higher pitched are stressed syllables where syllables which are relatively shorter, softer or lower pitched are unstressed.
Practice	Practice is the phase of therapy where the child learns the movement through repeated attempts and self-correction. It ensures the skill is retained over time.
Prepractice	Is the teaching phase of ReST therapy. The term comes from the motor learning literature and is aligned with the idea that before you can practice you need to know what the movement feels like. The prepractice or teaching phase is where the child acquires the movement.
Prosody	The rhythm and melody of speech. It is language, dialect and accent specific.
Smoothness	Term used in ReST therapy to describe fluent speech without syllable segregation or other disruption to the flow of speech.
Sounds	Term used in ReST therapy to describe segments or sounds
Sww	Lexical stress pattern of strong (stressed) syllable followed by two weak syllables. Also Sw(w) to indicate two syllables with an optional third. Most common pattern in English
wSw	Lexical stress pattern of weak syllable followed by the strong (stressed) syllable followed by a weak final syllable. Also wS(w) to indicate two syllables with an optional third. Less common pattern in English

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