# Phonomotor Treatment:

# Principles and Methods

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# Contents

# Introduction

Phonomotor Treatment (PMT) is a treatment for aphasia that is based in strengthening phonological skills. It is multi-faceted and complex, so this manual has been designed to help speech-language pathologists learn how to deliver PMT. It provides detailed explanations and examples that you can use to learn the basics of the program, along with quiz modules to help you solidify and integrate your understanding of PMT.

This is a comprehensive manual, intended to provide detailed information about the theory and practice of using Phonomotor Treatment (PMT) for treatment of individuals with aphasia. Information about PMT is already available through a number of avenues. To date, these include:

1) the research literature (Kendall, Hunting Pompon, Brookshire, Minkina, & Bislick, 2013; Kendall et al., 2006; Kendall, Oelke, Brookshire, & Nadeau, 2015; Kendall et al., 2008), with the Kendall et al. (2015) paper providing a quick reference guide for a speech-language pathologist wanting to implement this treatment in the clinic;

2) A fee-based video course published through MedBridge, available for continuing education credit at https://www.medbridgeeducation.com/courses/details/phonomotor-treatment-for-individuals-with-aphasia-evidence-based-practice)  (Disclosure: the second and last authors of this manual receive royalties from this course);

3) Educational presentations at national and state speech-language pathology (SLP) conferences; and

4) Resources that have been made available on the University of Washington Aphasia Research Lab website (https://sphsc.washington.edu/research-labs/aphasia-research-lab/professionals). This site is updated regularly as new information and resources become available.


Our hope is that these resources, collectively, will provide you with the tools you need to be successful with PMT.

We encourage you to take your time going through each section of this manual. Read the information and examples, watch the videos that are linked throughout, and review the case studies provided. Use the section quizzes to help you solidify and integrate your understanding of each aspect of PMT. Practice the tasks, keeping the written and pictorial aids that are provided here nearby for reference, and then review the relevant manual section and check your performance against what has been described.

Thank you for your interest in Phonomotor Treatment!

# What is Phonomotor Treatment (PMT)?

Phonomotor Treatment is an approach for treating impairments of phonology in people with aphasia. We define aphasia as an acquired impairment of access to language representations and processes that crosses all language modalities (verbal expression, auditory comprehension, reading, and writing) and involves impairments in attention and working memory, as well. This section reviews the models that PMT is based on. These models may or may not be familiar to you; those new to this information may benefit from reviewing this section several times and/or reading the articles referenced for these models. Having a solid understanding of these models will help make the rest of this manual, and the PMT program, much easier to understand and explain to your clients.

Originally based on the Lindamood Phoneme Sequencing (LiPS) program for developmental dyslexia (Lindamood & Lindamood, 1998), and using some of the same terminology, the underlying assumption of PMT is that phonology provides the fundamental building blocks for all language processing. This assumption is rooted in a parallel distributed processing model of phonology (Nadeau, 2001), an expanded version of which (Kendall, Oelke, Brookshire, & Nadeau, 2015) is illustrated in Figure 1.
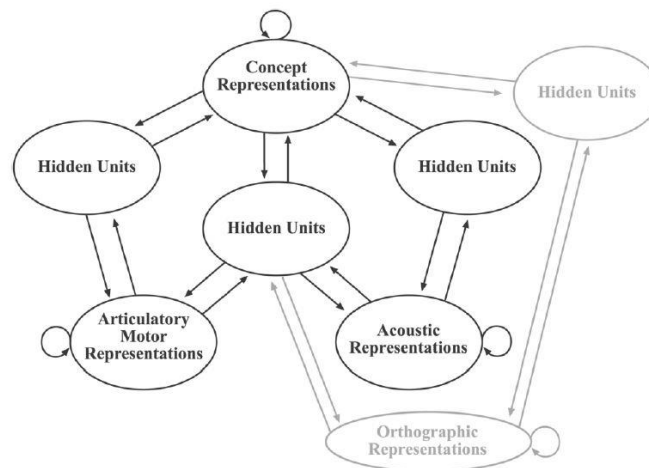


*Figure 1 - Parallel Distributed Processing (PDP) model of language (reprinted with permission from Kendall et al., 2015).*

This model posits that there are three primary domains involved in lexical processing: concept representations (semantics), articulatory motor representations and acoustic representations. These domains are all connected to each other through reciprocal connections, represented by the bidirectional arrows between domains (the "hidden units" represented in the model serve a function similar to old-time telephone operators, facilitating appropriate network connections between domains). In addition, each domain comprises smaller networks that are all connected within the domain, represented by the circular arrows attached to each bubble in the figure. **Representation is the result of the massive inter-connectivity of the network, with each word and concept representation emerging from the co-activation of a neural pattern that involves elements from each domain.** Two of the domains represented above, articulatory motor and acoustic representations, collectively underlie phonology. For individuals who have learned to read, orthographic representations are bound onto the network in the same fashion, with the same extensive connections.

Because of the highly inter-connected and distributed nature of representation in this system, treatment that focuses on one aspect of the system is expected to have far-reaching effects on its

connected elements in other domains. Specifically, because a limited number of phonemes and phoneme combinations are used in each language, addressing the limited domains that support phonology (articulatory motor and acoustic representations) would be expected to lead to improved processing throughout the language system, since all domains are so heavily interconnected. Changes in any domain should result in improved word retrieval because they are all critical subcomponents that work together for this purpose.

**PMT, therefore, is designed to facilitate and strengthen phonological representations and the ability to manipulate them, in both production and perception, with the ultimate goal of improving the efficiency, effectiveness, and accuracy of language processing across language tasks**. This is achieved through using a combination of tasks that reflect the interconnected nature of processing in all domains, represented in Figure 2. Importantly, the focus of PMT is on improving phonological awareness and phonological sequence knowledge in general. This is done by engaging visual, acoustic, orthographic, motor, and tactile representations and processes to "exercise" phonology.
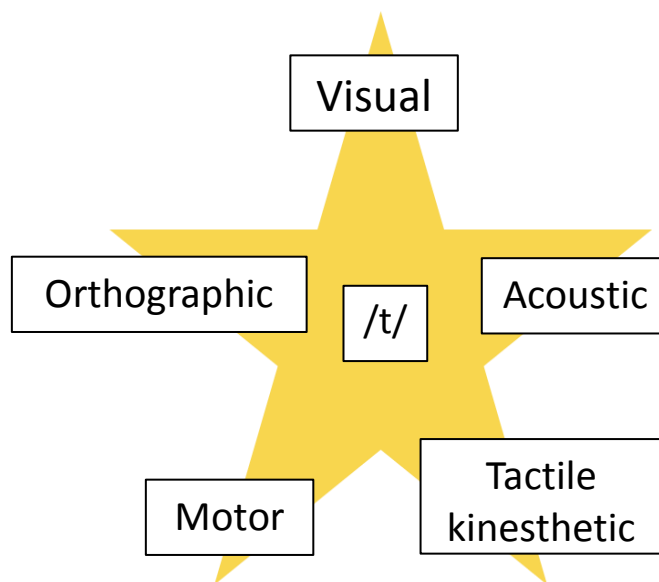


*Figure 2 - Illustration of the components of the multi-modality aspects of each phoneme's representation.*

The star depicted in Figure 2 underlies, motivates, and guides all therapeutic tasks in PMT. All tasks used in PMT address the domains shown here in a variety of ways:

- **Visual** tasks involve looking at the articulators (the SLP's, the client's in a mirror, and/or the mouth pictures) and focusing on their specific positions and movements.
- **Acoustic** tasks involve listening to and discriminating between stimuli based on their acoustic properties.
- **Tactile kinesthetic** tasks involve attending to and describing what a sound or sound sequence feels like; they do not necessarily involve saying the stimulus.
- **Motor** tasks involve production of stimuli, either in repetition or in response to some other stimulus.
- **Orthographic** tasks involve focusing on visual letter representations of sounds for both reading and writing.

Each task targets at least one of these domains, and often several at once. Stronger domains are routinely paired with weaker domains to build all aspects of the network. For instance, for someone with good ability to recognize and describe what they see but a weaker ability to do the same for what they hear, the clinician may have them look in the mirror to observe and identify notice oral movements while also asking questions and giving examples that highlight and contrast what the phonemes they're producing sound like.

As a client progresses in treatment, it is appropriate to reduce the pairing between modalities to provide opportunities to increase reliance on, and the strength of, each modality alone.

In addition to directly targeting these different linguistic domains, PMT also engages verbal short-term and working memory processes – which are fundamental to language function – in a number of ways (e.g., see Martin & Reilly, 2012). Tasks are designed to rely on these processes, gradually becoming more difficult by varying the number of linguistic elements and processing domains being used and manipulated, the amount and type of supporting cues being provided, and the length of time various elements need to be retained to complete a task.

A second model that motivates PMT is the Interactive Activation Model of language (Dell & O'Seaghdha, 1992). This model suggests that words are retrieved from a network that includes three levels of information: semantic, word form, and phonological (see Figure 3). These levels have reciprocal connections, so that activation at one level automatically spreads activation to related items at the other levels. Final selection of words occurs when feedback between levels causes the target word to have a higher level of activation than the other words surrounding it. Importantly for understanding why PMT works on phonemes, not real words, is that phonemes are fundamental to assembling word forms, and strengthening phoneme representations can influence multiple word forms because of each phoneme's bidirectional connections with all related words.
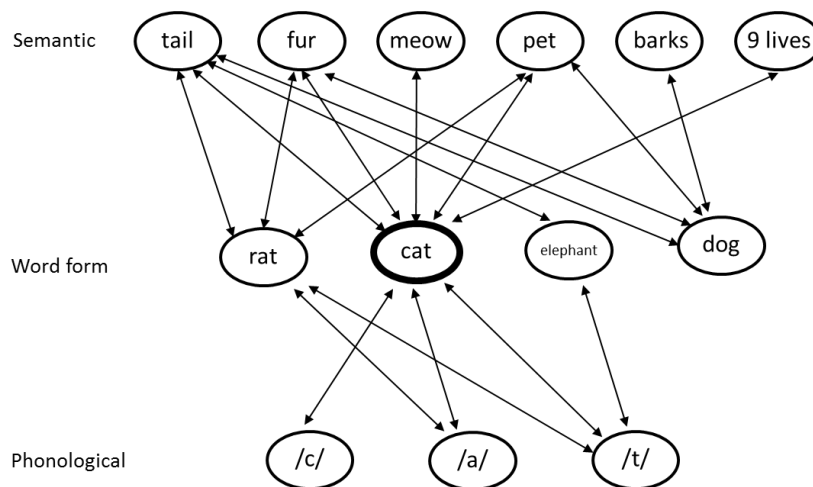


*Figure 3 - A partial lexical network as represented in an interactive activation model.*

Note that PMT is NOT intended to directly train the production and perception of specific single phonemes; instead, it is intended to build phonological awareness and phonological sequence knowledge. For many clinicians, this is a very different way to think about treatment. We encourage you to participate in the ongoing discussion on the PMT Manual website to help you adjust to and incorporate this new perspective on aphasia treatment.

## Quiz module – Theoretical motivations for PMT

1. Phonomotor treatment is based on the idea that lexical processing occurs…
   a. in a unidirectional manner with discrete units of information.
   b. in networks of individual elements that are affected only by elements in their own domain.
   c. in networks that are massively interconnected, with representation resulting from the co-activation of elements across domains.
   d. in a serial, sequential manner with little interaction between elements.

2. PMT is rooted in the understanding that lexical processing is supported by…
   a. discrete representations of words that contain all relevant information.
   b. the interaction of information across sensory-motor domains.
   c. a feed-forward system in which auditory and visual information are wholly independent.
   d. a system that relies more heavily on semantic than phonological processing.

3. In PMT, various behavioral modalities are routinely…
   a. paired between stronger and weaker modalities to facilitate improvement.
   b. treated independently of each other.
   c. treated in a sequential manner, with auditory information being established before other domains are engaged.
   d. separated to allow the client to focus on perfecting each domain.

4. The goal of PMT is to…
   a. Teach functional words.
   b. Teach specific sounds that are commonly used in English.
   c. Build phonological awareness and phonological sequence knowledge.
   d. Improve perception and production of single phonemes.

See answers and explanations for this quiz here: Quiz Module #1 – Theoretical motivations for PMT.

# How is the PMT program structured?

PMT involves both production and perception tasks, beginning at the level of single phonemes and moving up as appropriate to working with combinations of phonemes into syllables of increasing length. Individuals with aphasia typically progress to 2- and 3-syllable stimuli over the course of 60 hours of treatment. The general sequence of treatment progression is represented in Figure 4.
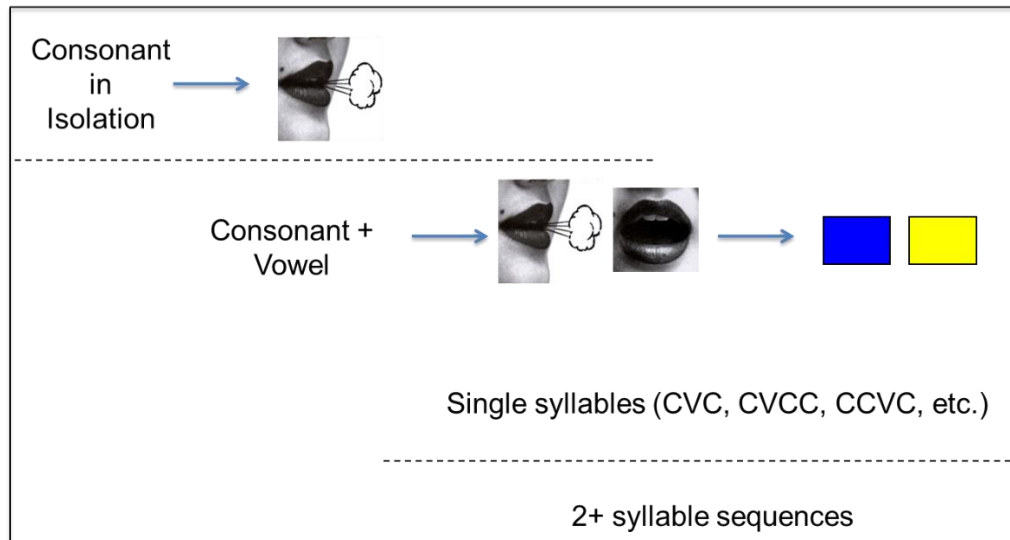


*Figure 4 - Overall general progression of tasks for each consonant in PMT.*
*Note that several different phonemes will be in play at the same time, so several phonemes would be available for any task (e.g., to create a CVCC, three different consonants may be used). The dotted lines reflect critical transition points: some phonemes may be used in combination with other phonemes while some are still being introduced in isolation, but no 2+ syllable sequences should be introduced until all phonemes have moved out of the isolation stage.  See text for details of how this is implemented.*

While the general progression of treatment is from single phonemes to syllables, with orthography introduced late in the program, there is not a strictly linear progression.  Once a client has learned a few consonants and is highly accurate (consistently ~80%) on a variety of tasks using those phonemes, you may begin manipulating them in simple CV and VC contexts while still developing knowledge of the remaining consonants. Think of it like learning to play an instrument: once you know a few notes or chords, you can begin stringing them together to make music even as you're learning other notes or chords for the first time. This idea is discussed in greater detail in the section on Progression through the task hierarchy, and is represented in Figure 5.
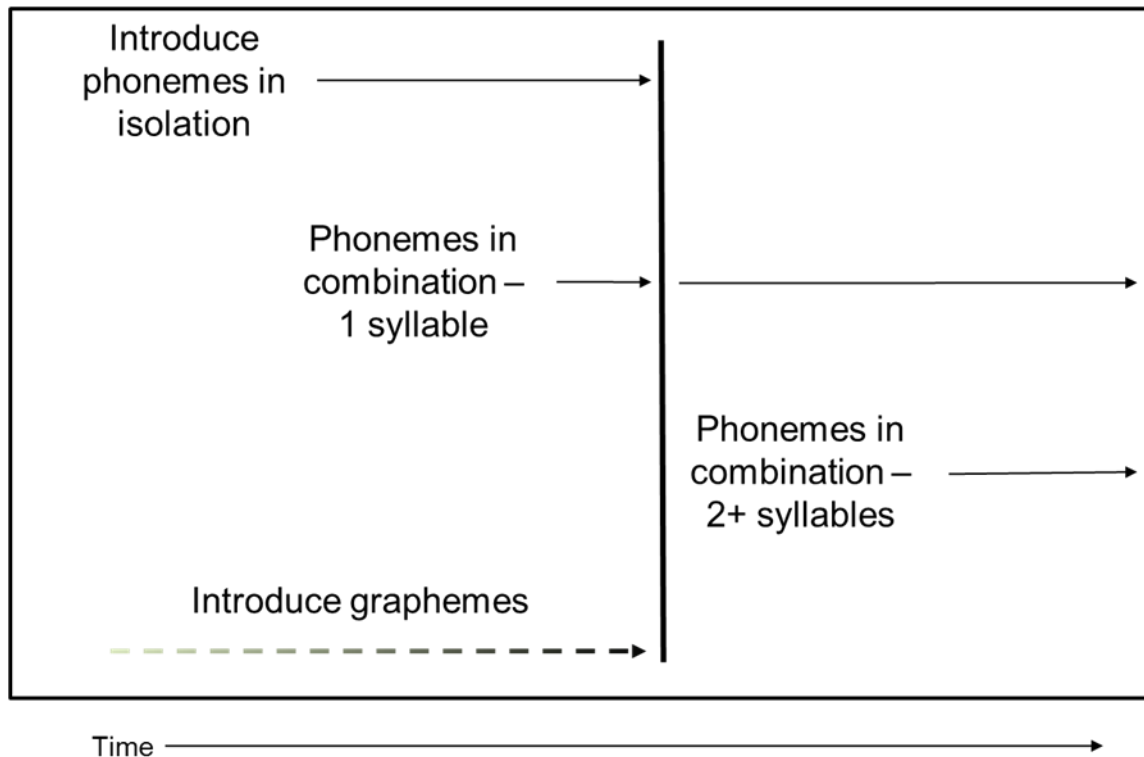
*Figure 5 - Overall progression of PMT program.*
*Phonemes are first introduced in isolation, and as each is established it is moved into 1-syllable combinations while other phonemes are still being introduced. Multi-syllable combinations are not used until all phonemes have been introduced. Graphemes are generally introduced later in treatment but may be introduced earlier depending on client abilities.*

To isolate and maintain a focus on phonology, treatment uses exclusively non-words initially; real words are introduced late in the program to facilitate connections with concept representations. Even when real words are used, however, the focus of treatment tasks remains on phonological aspects of the words, with no attention paid to their meanings. Details of treatment tasks, cueing methodologies, and progression hierarchies are provided below (see How to implement PMT, Socratic questioning: A fundamental element of PMT, and Anatomy of a treatment session).

## Quiz module – The structure of the PMT program

1. PMT begins with introducing single phonemes and then moves to working with phoneme combinations.
    a. True
    b. False

2. Treatment focuses on production of specific sounds, and a sound is considered "mastered" when the client produces it 100% accurately.
    a. True
    b. False

3. PMT uses only non-words in treatment.
    a. True
    b. False

4. Training of syllables only happens after all training of single phonemes is complete.
    a. True
    b. False

See answers and explanations for this quiz here: Quiz Module #2 – The structure of the PMT program

## What qualifications do I need to deliver PMT?

Phonomotor Treatment is intended for use by certified, licensed speech-language pathologists who have been adequately trained in its use. This training may include thorough study of the resources provided in this manual, along with practice prior to administering the treatment to clients. We also strongly encourage clinicians interested in using PMT to view the MedBridge course on Phonomotor Treatment, and to take advantage of the materials and videos provided on the University of Washington Aphasia Research Lab website (https://sphsc.washington.edu/research-labs/aphasia-research-lab/professionals) and linked in this training manual.

# Client candidacy for PMT

Good candidates for PMT typically meet the following criteria:
- Have a phonological processing impairment as part of aphasia, as documented by the presence of phonologic errors in a variety of linguistic contexts and/or performance on tests of phonological processing;
- Can repeat at least some single sound stimuli with cues;
- Are willing and able to be actively engaged in the treatment;
- Have sufficient auditory comprehension skills to participate in Socratic questioning;
- Are able to self-reflect (i.e., identify errors and change behavior to fix them);
- Have adequate speech motor programming, planning, and execution skills to participate in verbal treatment tasks;
- Have good executive function, including abstraction and set shifting.

In our experience, people who exhibit the following characteristics do not respond well to PMT:
- They do not have good buy-in, usually because they do not understand or like the concept of a treatment using primarily nonwords;
- They are unwilling to actively engage in the treatment tasks;
- They cannot be facilitated to repeat single sounds accurately;
- They have untreated depression.

PMT has been developed specifically for, and tested with, people with aphasia due to a left hemisphere stroke. No data are available that support its use with other etiologies; it may or may not be appropriate to use with other diagnoses that may yield acquired language impairments, such as traumatic brain injury or primary progressive aphasia.

# What supplies are needed to deliver PMT?

A clinician delivering PMT should have:
- A small mirror
- Laminated photos of mouth postures for each phoneme in the language
- Laminated icons for voiced and voiceless consonants
- Laminated blank vowel circle chart
- Grapheme tiles reflecting the orthographic system used in PMT (described below)
- A wipe-off board, markers, and eraser
- Small colored blocks – 3-4 blocks of each of 6 colors. Other colored objects, such as laminated paper squares, crayons, or beads, may also be used if blocks are unavailable.
- Colored felt squares – approximately 4" x 4" – they must be large enough to be able to lay out colored block or letter tile sequences on top of them
- Blank index cards

Also recommended:
- A clipboard for laying out the vowel chart, so it can be removed from the table quickly and easily without disturbing the array.
- A second set of laminated mouth pictures, to allow the full consonant array to remain in view while also having pictures available to manipulate.
- A second set of grapheme tiles to allow replication across stimuli presented simultaneously
- A "reset" button – this is typically just a small piece of paper with a red circle on it labeled "reset", which can be used as a physical and visual cue when the clinician or client feels the need to abandon an ongoing attempt at a task and start fresh. This may not be used with all clients, but some who are highly perseverative or persistent benefit from its presence.
- A large covered plastic bin for storing and transporting all treatment supplies.
- A tray to hold grapheme tiles (e.g., Scrabble racks).



*Figure 6 - Display of a complete set of supplies for PMT*

## Socratic questioning: A fundamental element of PMT

Socratic questioning is a process of asking leading questions to help a person discover truths on their own. A real-life example of Socratic questioning can be seen in this exchange between a parent and a child:

(Child is walking out the door to the school bus stop wearing socks, carrying shoes. It is raining.)
Parent: I see you're heading out to the bus.
Child: Yep.
Parent: What's the weather like?
Child: It's raining.
Parent: What do you have on your feet?
Child: Socks.
Parent: What do you think will happen to your socks if you go out in the rain like that?
Child: Oh – they'll get wet.
Parent: What happens if your socks get wet?
Child: They'll be wet all day at school.
Parent: Is that going to be comfortable?
Child: Not really.
Parent: So what can you do to avoid that?
Child: I guess I should put on my shoes.

While any parent can tell you that this exchange is idealized, you can see in this example that, rather than just telling the child what's wrong and what to do about it, the series of statements and questions leads the child through the logical steps needed to come to a conclusion about what they should do. The process began with helping the child focus on and state the obvious aspects of the situation and then moved toward helping them synthesize the information to make appropriate behavioral change.

Similarly, PMT uses Socratic questioning as the primary form of both stimulus presentation and clinician feedback to client responses. Rather than the clinician providing all of the information, or telling the client whether they got something right or wrong, Socratic questioning is used to help the client discover and understand the information and evaluate and correct their own responses. Questions may encourage explanation and recall of concepts, analysis of stimuli, or analysis of their own or the clinician's productions or responses.

Socratic questioning in PMT typically serves one of three purposes:

| Type of question | Examples |
| --- | --- |
| Questions to encourage explanation, exploration, and recall | What kinds of things can make sounds different from each other? <br> What do you remember from last time about this vowel chart? |
| Questions for analysis of stimuli | Is this a quiet or a noisy sound? <br> What would your mouth do for this sound? <br> What did my lips do? <br> Were these the same or different? <br> Where should your jaw be? <br> How many syllables, or beats, does that word have? <br> You said there were three sounds in that syllable. What were they? |
| Questions for analysis of responses (both correct and incorrect) | Did we match? <br> Was the sound you said the same as the sound I said? <br> I said "p" and you said "b". Same or different? |

As much as is possible, clinicians should guide clients through treatment tasks and feedback through a series of questions that the client answers themselves, rather than having the clinician providing most of the information and right/wrong feedback. ***If you are doing most of the talking, something is wrong!***

It is important to recognize that the process of Socratic questioning involves asking multiple questions in a sequence that will guide the client to self-discovery. The various types of questions presented here will always be used in conjunction with each other to facilitate this process. Questions should generally be tied to physical (tactile-kinesthetic), acoustic, or visual cues that focus the client's attention on relevant aspects of the stimulus, task, or their own behavior. For example, these cues could include:

- Looking in the mirror to see their own articulator placement *(using visual cues to support motor and acoustic modalities)*
- Watching the clinician's mouth *(using visual to support acoustic modality)*
- Feeling their own or the clinician's neck for vocal fold vibration *(using tactile-kinesthetic cues to support acoustic modality)*
- Focusing on specific articulator movements (e.g., Is your tongue moving? Is it the front of your tongue or the back of your tongue? Is your neck vibrating?) *(using tactile-kinesthetic to support visual and/or acoustic modalities)*
- Plugging their nose (to determine whether a sound is a "nose sound") *(pairing tactile-kinesthetic and auditory cues, possibly to support visual modality)*
- Listen to a model or their own production for specific features (e.g., Is it quiet or noisy? Do these sounds match? What's the difference between these two words?) *(pairing acoustic and motor modalities to reinforce explicit phonemic awareness)*

Because Socratic questioning focuses on the client's attention on one or more aspects of the sound and its connections across domains, as represented in Figure 2, it is used to connect weaker with stronger modalities. For instance, if a client has difficulty with recognizing acoustic characteristics of phonemes but is particularly good at identifying their visual aspects, questioning may link the two, as follows:

(Target phoneme: /p/)
SLP: "p". What did my lips do? (FOCUS ON VISUAL ASPECTS)
Client: They came together and then opened.
SLP: Look in the mirror and you say it.
Client (looking in the mirror): "p"
SLP: What did your lips do? (FOCUS ON VISUAL ASPECTS)
Client: Came together and then opened.
SLP: Now listen to it again. "p". Was it a long sound or a short sound? (FOCUS ON ACOUSTIC
        ASPECTS)
Client: "p". A short sound.
SLP: What did the air do? (LINK THE VISUAL AND ACOUSTIC ASPECTS)
Client: It stopped and then came out when my lips opened.
SLP: And what about your voice? Put your hand on your throat and say it again. Was this sound
        quiet or noisy? (FOCUS ON ACOUSTIC AND ARTICULATORY KINEMATIC)
Client (with hand on throat): "p". It's quiet.

In the event that a client gives an incorrect response to a question, the clinician may narrow the questions to focus even further on fewer or more concrete aspects of the task, such as:

SLP: Listen to this sound: "p". Is it a long sound or a short sound?
Client: A long sound. (INCORRECT RESPONSE)
SLP: Listen to it again: "p". Does the air stop, or does the air keep going when I say it?
Client: The air keeps going. (INCORRECT RESPONSE)
SLP: Put your hand in front of your mouth and you say it: "p". (PAIR AUDITORY AND TACTILE)
Client (with hand in front of lips): "p".
SLP: Did the air flow smoothly or did it stop and then puff out? (FOCUS ON THE SAME ASPECTS
   IN MORE DETAIL)
Client: It stopped and then puffed out.
SLP: So is it a long sound, where the air keeps moving, or a short sound, where the air stops?
Client: It's a short sound.

If the client were to still get it incorrect after adding the tactile cue, the exchange could end like this:

SLP: Did the air flow smoothly or did it stop and then puff out?
Client: It flowed smoothly. (INCORRECT RESPONSE)
SLP: Put your hand in front of your mouth again and say "p", "h".
Client: "p", "h".
SLP: Do you feel that "p" has a puff of air and "h" has the air just flowing the whole time?
Client: Yes.
SLP: That puff of air means it's a short sound. It's short because you can't keep it going. Let's try
   another one…

Remember that the goal is not 100% accurate production; it is increasing awareness and knowledge of phonology. Incorrect responses provide an opportunity to build awareness and knowledge that can then be applied to different targets.

The focus of Socratic questioning will shift as treatment progresses; questions will be more exploratory at first, to establish and strengthen awareness of phonemic representations, and then will shift to become more analytic as skills and representations improve. At any level, Socratic questioning initially aims to link stronger modalities with weaker modalities, allowing the weaker skills to improve by "bootstrapping" on the stronger. Later in the treatment program, Socratic questioning may focus on a single modality to encourage its further strengthening and development. Examples of Socratic Questioning in action can be found in all videos linked throughout this document. Examples of feedback and cueing that are NOT Socratic Questioning, and are to be avoided, can be seen at https://canvas.uw.edu/courses/1166215/pages/video-examples-how-not-to-do-pmt.

For better understanding of the idea of pairing modalities, refer back to the section on What is Phonomotor Treatment (PMT)? and ahead to the section on Suggested tasks for reinforcing single phonemes.

At later stages of treatment, Socratic questioning may be less directive and more open-ended. Questions for higher level clients could include:
- Listen to these two words. Are they the same or different?
    - What sound is different between them?
    - How are those two sounds different?

     o  What does your mouth do for that sound in the first word? The second word?
  -  What sound in this word changed?
     o  How are the old sound and new sound different?
     o  Show me (using blocks or grapheme tiles) which sound changed.

For any of these, Socratic questioning may return to more a basic, feature-directed focus if the client has difficulty with these more open-ended questions or does not capture all appropriate aspects in their response.


## What if my client has poor auditory comprehension? How can I implement Socratic questioning?

    A client with poor auditory comprehension can still participate in PMT, although the Socratic questioning process will need to be adjusted. Some strategies to consider include:

- Supplement questions with key word writing, drawing, or gesture.
- Supplement questions with icons and symbols found in the PMT materials (e.g., the quiet/noisy icons, mouth pictures, letter tiles, etc.).
- Make questions shorter and simpler.
- Ask yes/no questions with concrete choices, or forced choice questions with a limited set of linguistic or non-linguistic response options, rather than requesting complex descriptions (see examples in Figure 7).
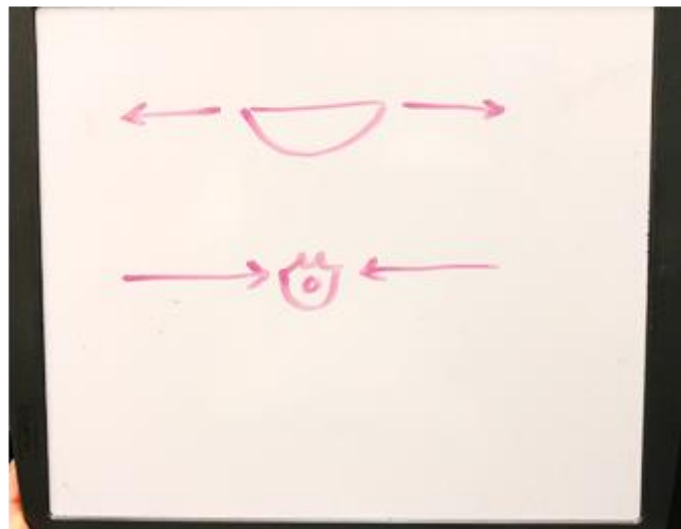


*Figure 7 - Examples of visual supports for Socratic questioning with clients who have poor auditory comprehension. The drawing on the right represents "lips spread" versus "lips puckered".*

## Quiz Module – Socratic questioning

1. Socratic questioning involves…
   a. Using carefully crafted questions to guide the client through exploration of phonemes, stimuli, and their own responses to treatment tasks.
   b. Giving explicit feedback on every production that a client makes.
   c. Having the client ask questions about each sound and sound sequence to learn about it.
   d. Giving multiple choice questions after each task is complete so that the client can assess how they did.

2. Socratic questioning for a single trial usually involves just a single question.
   a. True
   b. False

3. The clinician should always use the same questions for the same tasks during PMT.
   a. True
   b. False

4. Socratic questioning evolves over the course of treatment, depending on the client's strengths, challenges, and current level of success.
   a. True
   b. False

5. Socratic questioning should facilitate linking relatively stronger with relatively weaker modalities.
   a. True
   b. False

6. A client with impaired auditory comprehension is not a good candidate for PMT, because auditory comprehension needs to be fully intact to participate in Socratic questioning.
   a. True
   b. False

7. The best way to support a client's ability to engage in the Socratic questioning process is to…
   a. Provide written key words.
   b. Simplify questions.
   c. Provide yes/no or multiple choice questions.
   d. All of the above.

See answers and explanations for this quiz here: Quiz Module #3 – Socratic Questioning

# How to implement PMT

## First session: Pre-treatment conceptual explanation

PMT is unusual in that it focuses on sub-lexical elements and does not introduce real words until late in the treatment process. Since most people with aphasia have experienced treatment focused on functional vocabulary, and it is counterintuitive to not work on real words when the ultimate goal is improved verbal communication, it can be difficult for clients to understand the purpose of extensive exercises that do not incorporate real words at all. ***Therefore, in the first treatment session, before treatment begins, it is important that the clinician explain the purpose of the treatment approach in a way that is accessible and clear to the client and any caregivers or family members who may be involved.*** You may also find it useful to revisit this explanation during the treatment program if your client seems to have lost motivation or understanding of the purpose of the treatment approach.

This process begins with drawing a rough sketch of a brain (see Figures 8-12) and using this, along with gestures toward your own head and the client's head, to explain that:

1) Different parts of the brain are involved in different things
   - Broca's area plays an important role in speech
   - Wernicke's area plays an important role in auditory comprehension
   - the angular gyrus plays an important role in letter processing
   - the occipital lobe is important for visual processing
   - the sensorimotor cortex is important for feeling and movement
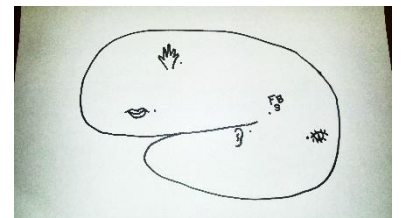


*Figure 8*

(Note that you do not need to name each area as you point it out and describe it, if you think that will be too much information for the client.)

2) These areas are usually connected to each other and communicate with each other – they all work together to make language happen.
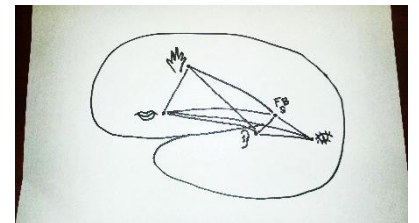


*Figure 9*

3) The front of the brain is also involved, working as a conductor to let you think about language and keep it all running smoothly.
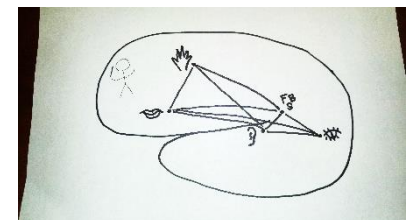


*Figure 10*

3) When you have a stroke and it causes aphasia, some of those connections are damaged or broken.
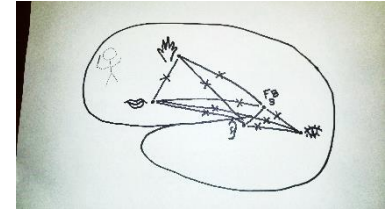
*Figure 11*

4) The goal of therapy is to work on making those connections strong again.
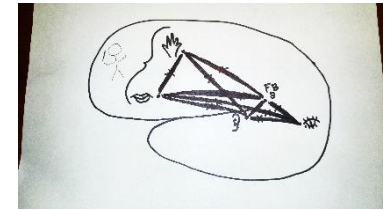
*Figure 12*

5) That's why there will be so many different types of tasks involved – they all help the whole network.

To assist comprehension and memory, create the drawing as you speak, rather than just using a completed drawing and pointing to it. This helps maximize client understanding by breaking the ideas into manageable pieces, adding each element as it's discussed, and providing multi-modal communication support.

The second concept to be discussed in this session is why treatment focuses on sounds in non-words. The points to include in this discussion are typically:

1) All of the tasks used in this therapy are based on working with speech sounds.

2) Sounds are the building blocks of all language processing. When you learned to speak, you started with babbling individual sounds and then learned how to string them together. Now, when you speak, listen, read, or write, you use this knowledge of speech sounds and how to combine them.

3) Aphasia leads to problems with using speech sounds and being able to string them together into larger units, like words and sentences, that make up connected language.

4) The goal of this treatment is to make those speech sounds in your brain, and to make it easier for you to manipulate them and string them together. If we worked with real words, your brain would rely on the meanings of the words to help process them, and it wouldn't have to work as hard on the sounds. So we'll be using made-up words so that your brain has to focus on the sounds.

5) It takes a lot of practice for your brain to get better at doing this, so treatment is going to involve a lot of repetition and observation.[1]

6) (Refer back to drawing) Every sound has lots of different things that help describe it – what it feels like to say it, what it sounds like, what it looks like to say it, what letters represent it in writing.

7) So our treatment activities will focus on all of these different aspects of the sounds, making the connections in your brain stronger.

It can be useful to accompany this discussion with a simplified drawing of a lexical network from a 2-stage interactive activation model of language (e.g., Dell, 1986), particularly for higher level clients. This drawing should highlight that phonemes, word forms, and semantics are connected but separate, in a network that lets information flow both ways between levels. This drawing helps to show how working with phonemes in non-words can have an influence on processing of real words. For an example of this type of drawing, see Figure 13. This drawing can then be used as needed throughout therapy if the client needs reminders about why treatment is focused on non-words.
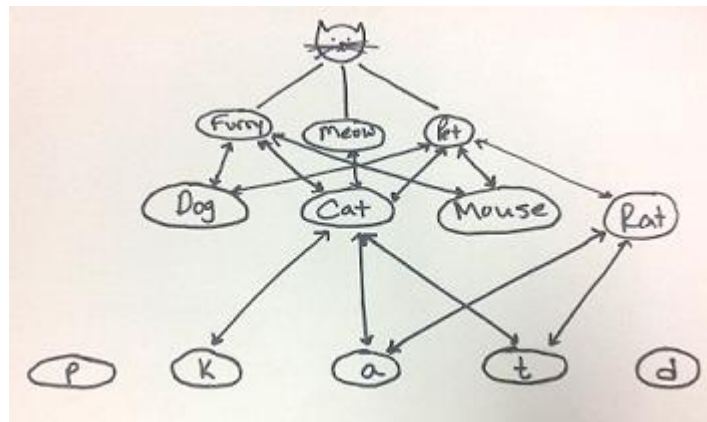


*Figure 13 - Explanation of a two-step interactive activation model of language.*

In the case of lower level clients, this model of word retrieval is not typically appropriate to present at the start of therapy. Instead, when non-words are first introduced after a few hours of treatment, a simple "Non-words help us find real words", accompanied by a simplified version of this drawing, may suffice.

You can see examples of how this initial conversation before treatment begins may unfold at https://canvas.uw.edu/courses/1166215/pages/video-examples-pre-treatment-conceptual-explanation.

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[1] Pro tip: Some clients are inclined to try to analyze and understand every aspect of every task, but this can distract from treatment. You can return briefly to basic explanation, but work to keep them focused on doing the tasks rather than understanding them.

Quiz module – Conceptual introduction to PMT

1.  PMT is intuitive enough that you can jump into treatment without any preliminary explanation.
    a.  True
    b.  False


2.  The explanation and drawing that represent the purpose of PMT should be provided at the start of each treatment session.
    a.  True
    b.  False


3.  The explanatory drawing that represents the purpose of PMT should be created anew for each client as you describe the purpose of the treatment, rather than having it pre-drawn.
    a.  True
    b.  False


See answers and explanations for this quiz here: Quiz Module #4 – Conceptual introduction to PMT

## A framework for introducing individual sounds in isolation

The first step in treatment is to train each sound in the language in isolation. Initial sound training is designed to build a strong representation of all aspects of a phoneme, including knowledge of its articulatory shape, tactile-kinesthetic aspects, voicing status, sound, and orthographic representation. In addition, a framework for organizing sounds that are similar is also introduced early in treatment. All consonants are introduced first, followed by all vowels. The descriptions and cues introduced early in treatment become the framework for cueing and Socratic questioning that will be used throughout the treatment program, and will be used repeatedly throughout treatment progression to reinforce knowledge or facilitate progression to more complex stages of processing.
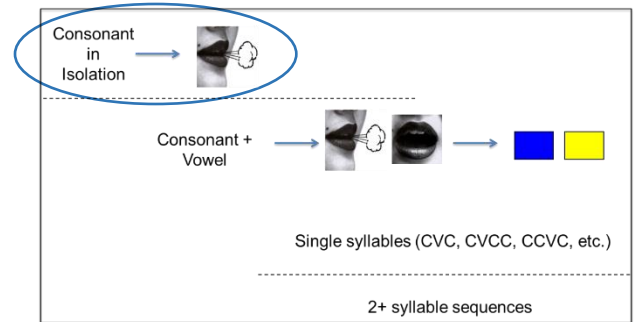
### Consonant training sequence

Consonants are trained in cognate pairs in the following sequence, organized by place or manner of articulation, with characteristic descriptors as noted in Table 1.

*Table 1 - Descriptions of each consonant*

| Consonant | Sound category | Characteristics |
|---|---|---|
| p/b | Lips | Air stops, lips together and pop open, puff of air, quiet (p)/noisy (b) |
| f/v | Lips | Continuous air, top teeth on bottom lip (bite the bottom lip), quiet (f)/noisy (v) |
| t/d | Tongue | Air stops, tongue tip taps up behind front teeth, puff of air, quiet (t)/noisy (d) |
| k/g | Tongue | Air stops, back of tongue goes up and down (taps the back of the palate), puff of air, quiet (k)/noisy (g) |
| th/<u>th</u> | Tongue | Continuous air, tongue between teeth (like you're biting your tongue), quiet (th)/noisy (<u>th</u>) |
| s/z | Air* | Continuous air, "skinny" (or "thin") air, lips back (smile), teeth closed, quiet (s)/noisy (z) |
| sh/zh | Air* | Continuous air, "fat" (or "big") air, lips rounded, teeth together, quiet (sh)/noisy (zh) |
| ch/j | Air* | "Fat air, burst" - Air stops, lips rounded, teeth together, puff of air, quiet (ch)/noisy (j) |
| l/r | Tongue placement | Continuous air, tongue lifts up (small, front vs. big, back) |
| m/n/ng | Nose | Continuous air, sound comes through nose, noisy, close off the air from coming out of the mouth so it has to come out the nose (close off at lips, front of tongue, and back of tongue). |
| h/w/wh | Windy | Continuous air, quiet, mouth wide open. For w/wh: two mouth movements (from puckered to open) |

*When training air sounds, use the back of your/the client's hand to provide tactile feedback for airflow.

## Consonant family relationships

The lip, tongue, and air sounds are often referred to as "brother" sounds, because they all fit nicely into articulatory categories. The remaining consonants are more abstractly grouped, and are often referred to as "cousin" sounds. These terms are used throughout this manual as an easy way to differentiate the two broad groups. You can see how this may be explained to clients at https://canvas.uw.edu/courses/1166215/pages/video-examples-introducing-and-practicing-single-phonemes.

## Vowel training sequence

Before beginning formal training on vowels, explain that you're going to start now with a new set of sounds. The sounds you've been doing up until now have been consonants, and this new set is vowels. There is no need to provide detailed explanation of what makes a sound a consonant or a vowel; simply labeling them is enough.

Vowels are trained by introducing the extremes of the vowel triangle (see Figure 14) – contrasting the three extreme corner sounds (*ee*, *o/au/aw*, and *oo*[2], known as *anchor vowels*) first, and then building gradations between them, from *ee* down to *o/au/aw* and then up to *oo*. Monophthongs are taught first, and then rhotics and diphthongs are introduced. The grapheme tiles for vowels are used from the beginning of their training, as there are no mouth pictures for them.

The training sequence, with descriptive characteristics, is presented in Table 2. Along with the descriptive characteristics of lip shape, the SLP should demonstrate and reinforce changes in jaw height for each vowel by placing their hand under their own jaw, and having the client do the same, as vowels are contrasted verbally. Brief descriptions of tongue position and movement may be included, as well. Examples of how vowels are introduced and practiced may be seen at https://canvas.uw.edu/courses/1166215/pages/video-examples-introducing-and-practicing-single-phonemes.

Note that some people have a very difficult time with the vowels, often due to apraxia of speech and the lack of concrete articulatory details as compared with consonants. If a client is doing well with vowels, then it is worth spending time on them. If a client is really struggling, though, due to concomitant apraxia of speech, then it is appropriate to just establish the three anchor vowels (*ee*, *o/au/aw*, and *oo*), and then incorporate the others in other tasks without the specific detail to jaw height, lip rounding, etc. that would have been introduced in more thorough direct vowel training.

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[2] NOTE: Unless otherwise noted, all examples of phonemes and words presented in this manual are written using PMT orthography using italics. Consonants are all consistent with regular English orthography (see Table 1), but vowels differ (as described in Figure 14 and Table 2). References to specific letters of the alphabet are written in capitals with single quotations around them. Real English words given as examples in standard English spelling are written in lower case letters with single quotation marks.
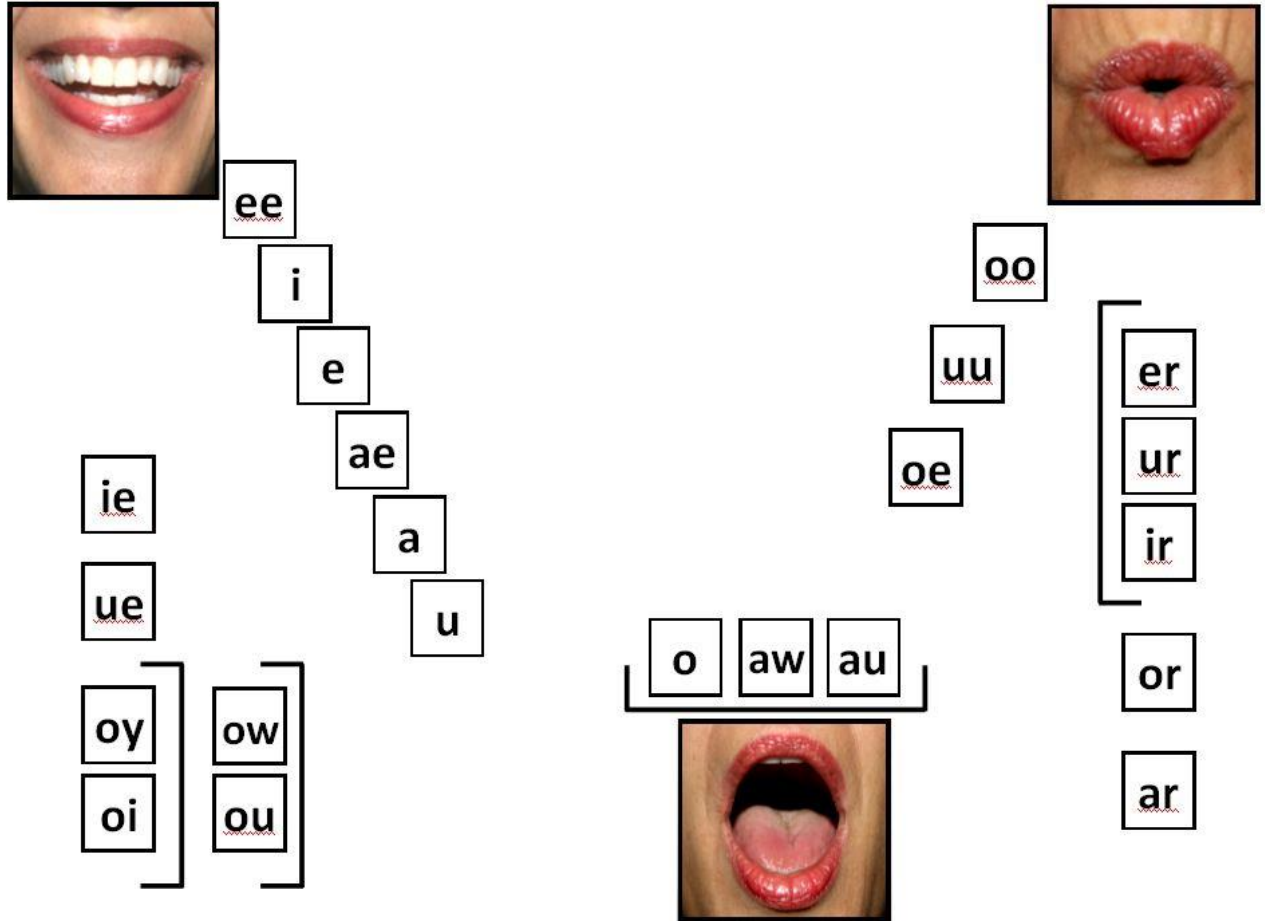
*Figure 14 - Complete vowel circle*

*Table 2 - Descriptions of each vowel*

| PMT orthographic representation | IPA representation | Pronunciation | Characteristics |
|---|---|---|---|
| **MONOPHTHONGS:** | | | |
| **Anchor vowels** | | | |
| ee* | /i/ | b<u>ee</u>, s<u>ea</u>, m<u>e</u> | Jaw high, lips in a smile, tongue high |
| o / aw / au** | /a/ and/or /ɔ/ | c<u>o</u>t, s<u>aw</u>, c<u>augh</u>t | Jaw all the way down, lips loose and open |
| oo | /u/ | f<u>oo</u>d, d<u>o</u>, st<u>ew</u> | Jaw high, lips very round |
| **Intermediate vowels** | | | |
| From *ee* down to *o / aw / au* (smile to open): | | | |
| i | /ɪ/ | p<u>i</u>t | One step down the ladder from "ee" |
| e | /ɛ/ | r<u>e</u>d | One step down the ladder from "i" |
| ae* | /eɪ/ | r<u>ay</u>, sl<u>eigh</u>, ob<u>ey</u> | One step down the ladder from "e" |
| a | /æ/ | c<u>a</u>t | One step down the ladder from "ae" |
| u | /ə/ or /ʌ/ | c<u>u</u>p, s<u>o</u>me | One step down the ladder from "a" |
| From *o / aw / au* up to *oo* (open to round): | | | |
| oe* | /o/ | h<u>o</u>me, b<u>oa</u>t, c<u>o</u>mb | One step up the ladder from "ah" |
| uu | /ʊ/ | p<u>u</u>t, c<u>oul</u>d | One step up the ladder from "oo" |
| **DIPHTHONGS and RHOTICS:** | | | |
| ie* | /aɪ/ | r<u>i</u>de, s<u>igh</u> | Slider; start with "a" and slide to "ee" |
| ue* | /ju/ | <u>u</u>se, <u>you</u>, c<u>ue</u> | Slider; start with "ee" and slide to "oo" |
| oy / oi | /ɔɪ/ | b<u>oy</u>, j<u>oi</u>n | Slider; start with "uu" and slide to "ee" |
| ow / ou | /aʊ/ | c<u>ow</u>, m<u>ou</u>th | Slider; start with "a" and slide to "oo" |
| er / ir / ur | /ɚ/ | h<u>er</u>, f<u>ir</u>, f<u>ur</u> | R vowel |
| or | /or/ | door | R vowel |
| ar | /ar/ | jar | R vowel |

\* If a client has difficulty remembering the sounds associated with these graphemes, some people understand it and remember it better if they are told that having an 'E' after the vowel makes it say its own name. For instance, a letter 'A' written with a letter 'E' after it (i.e., *ae*) says the name of the letter 'A', 'O' with an 'E' after it (i.e., *oe)* says the name of the letter 'O', etc. Laying out the vowels 'A', 'E', 'I', 'O', and 'U' in canonical order can help to demonstrate this point.

** In some dialects, the vowel in 'saw' and 'caught' is different from the vowel in 'cot'. In these cases, you may choose to use *aw* and *au* interchangeably to reflect the former and *o* to reflect the latter. Alternatively, some clients will automatically name the letter 'O' when you show the grapheme *o*, in which case it may be more effective to only use *aw* and *au* for all instances. If a client is confused by the three different ways of representing this vowel, it generally helps if you put all three out at the same time and circle them to indicate that they're interchangeable.

## Incorporating different modalities in treatment tasks

One final concept that's important to clarify before thinking about specific procedures in PMT is how different modalities (think of the yellow star presented in What is Phonomotor Treatment (PMT)?) get incorporated and manipulated within a single task.

As discussed previously (see the section beginning on page 6), a primary objective of PMT is to pair modalities to help the stronger support the weaker, with the ultimate goal of having all modalities strong enough to be able to support themselves. As a general rule, the more modalities a single task incorporates, the easier it should be. As a client progresses through PMT, multi-modality supports can be reduced, with the highest level, most challenging tasks relying on just a single modality.

For any task in PMT, you should think separately about a) What is its primary goal? and b) How you are going to achieve that goal? Your answers to these questions will reflect where the client is in the program and what their relatively stronger and weaker modalities are; the modalities used to achieve the tasks may differ based on these answers. For instance, consider a task that involves parsing a syllable into its component phonemes (e.g., "bif" → *b*, *i*, *f*). The primary objective of this task is the ability to recognize and isolate phonemes in a longer string. There are many ways this task can be presented, though, to achieve the same outcome. For a client who is doing this for the first time, the input may be auditory, visual, and orthographic; you may place colored blocks representing the three sounds on the table in front of them, place the appropriate orthographic tiles in front of each block, and say the word for them while scanning your finger across the blocks so that you're pointing to each sound as it's pronounced (see the section on Suggested tasks for training sounds in combination for details on tasks using blocks). This presentation combines modalities to give visual and orthographic support to the auditory task of phoneme discrimination. With a higher level client who is further along in the PMT program, you may present the same task with just an auditory stimulus and the blocks laid out. For someone even more advanced, you may remove the blocks altogether and have them do the task using only the auditory modality for input and the verbal modality for output. In all of these cases, the primary objective remains the same but the way it is achieved differs based on the client's needs.

In the following sections on PMT procedures, tasks are described in terms of their primary objectives and their input and output modalities. Keep in mind that the input and output modalities may differ as you adjust tasks within and between sessions and clients. As long as you are focusing on multi-modality awareness of phonology and phonological sequences, you are still operating within the framework of PMT.

## Training single phonemes

### Procedure for introducing consonants: the first cognate pair – *p/b*

This is the general procedure for introducing the first cognate pair (*p/b*), during which you also introduce many of the basic elements of PMT, including explaining the mouth pictures, the quiet/noisy icons, and first use Socratic questioning. This procedure should be adjusted as needed based on the client's response. Examples of how this procedure may be implemented can be seen at https://canvas.uw.edu/courses/1166215/pages/video-examples-introducing-and-practicing-single-phonemes.

1. Demonstrate the sound while the client just watches and listens.
2. Ask the client to tell you what they saw moving when you made the sound.
3. Have them say the sound following your model.
4. Have them look in the mirror while they say the sound a few times.
5. Restate the movement that they said they saw, and ask for more detail if appropriate (e.g., "You lips are moving. Can you be more specific?)
6. Ask about other articulators (e.g., "Is your tongue doing anything when you make that sound?").
7. Introduce the mouth picture, tell the client that it represents that sound, and have them say the sound 10 times while looking at the mouth picture.
8. Introduce the voiced cognate – Have them say the sound a few times, including while looking in the mirror.
9. Ask them to describe what they saw happening when they made the sound (i.e., it's the same as the other sound).
10. Reinforce that the sounds look alike, but they sound a little different.
11. Have them place their hand on their throat and make the two sounds.
12. Ask them what they felt happening with the second sound and then use their response to explain "noisy" sounds. Introduce "noisy" icon and place it on one the bottom right corner of the mouth picture.[3]
13. Have them say the second (voiced) sound again 5-10 times while looking at the combined mouth picture/noisy icon.
14. Tell them that the first sound had no moving, no vibration at all, so it's a quiet sound. Introduce "quiet" icon and place it bottom left corner of the mouth picture.
15. Have them say the quiet sound 5-10 times, while looking at the combined mouth picture/quiet icon.
16. Have them say each sound 10 times in a row (p then b), then 5 times each, then 3 times each, then alternating 1 time each.
17. Have them listen to you say one and they choose which you've said (random order).
18. Have them say each sound as you point to it, with no verbal model (random order). If they cannot do this, have them do blocks of 5 repetitions again with a model, then move on to the next cognate pair.

---

[3] Pro tip: Use *h* vs. *o* / *aw* / *au* to demonstrate the concepts of quiet vs. noisy.

## Procedure for training consonants: subsequent consonant sets

Introduce each consonant pair in a similar way, with appropriate descriptors (see Table 1, above). When a client has been introduced to all of the cognate pairs in one of the three primary articulatory groups (lips, tongue, air), give them a blank index card and ask them to draw a picture to represent that group in a way that makes sense to them (see Figure 15). Then place that card at the top of the column of mouth pictures representing that group. That label card should be used every time the array of mouth pictures is presented.
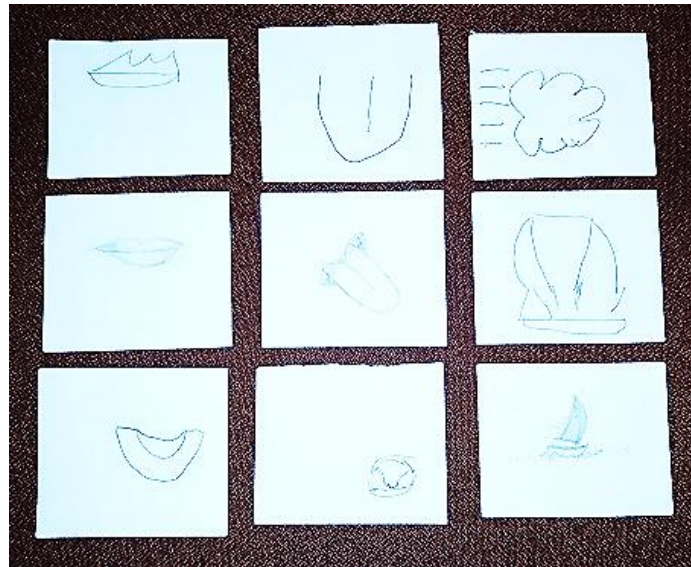


*Figure 15 - Examples of category label drawings created by different clients receiving PMT.*
*The pictures in the column on the left represent lip sounds, those in the middle column represent tongue sounds, and those in the column on the right represent air sounds.*

A complete array of consonant sounds, as it would be displayed to a client who has been introduced to all consonants can be seen in Figure 16 (before graphemes are introduced, using the "quiet" and "noisy" icons to differentiate voicing cognates) and Figure 17 (once graphemes have been introduced).
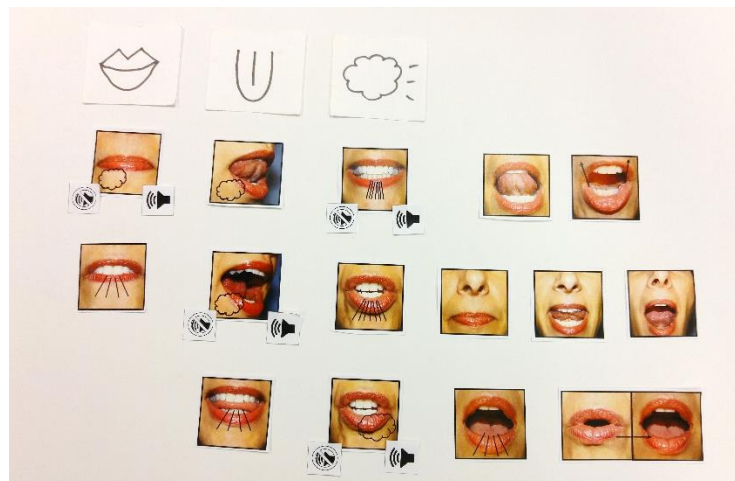


*Figure 16 - Full consonant array before graphemes have been introduced.*
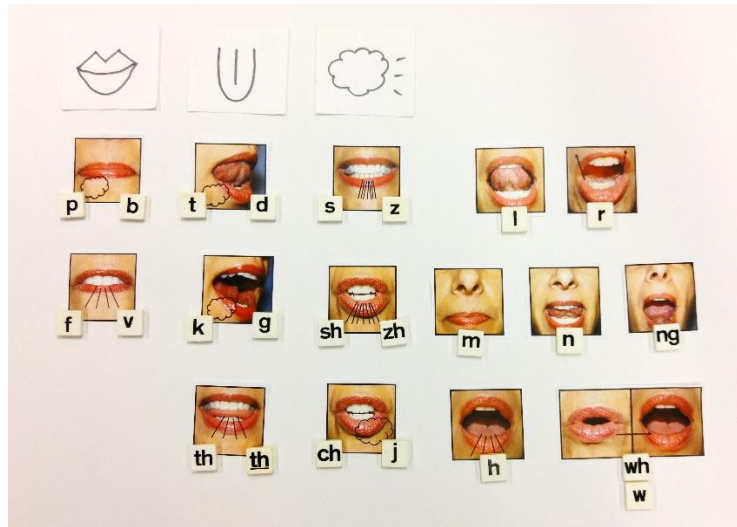
*Figure 17 - the full array of consonant mouth pictures
laid out by sound group, once orthography has been introduced.*

## Procedure for introducing single vowels

Once a client has learned a few consonants and is highly accurate (consistently ~80%) on a variety of tasks using those consonants, initial training may begin on the three anchor vowels: *ee*, *o / aw / au*, and *oo*. Trained consonants can then be presented in CV and VC contexts using these vowels, while continuing to develop knowledge of the remaining consonants. In this case, the vowels are introduced only through demonstration and brief teaching of the associated mouth pictures and/or graphemes; detailed analysis of the motor movements is deferred until vowel training officially begins.

Once all consonants have been introduced, it is time to start focused training with vowels. This training begins with the anchor vowels, but this time they are fully introduced and explored, much in the same way that consonants were taught (though the motor descriptions are quite different). Once the anchor vowels are established, the intermediate vowels are introduced, moving from *ee* down to *o / aw / au* (*i, ae, e, a*), and then from *o / aw / au* up to *oo* (see Table 2).

Vowel training follows the same general format, and uses the same types of tasks, as consonant training; however, the focus is on jaw height and lip rounding, rather than articulator position and voicing. Tongue position is generally not addressed, given that this parameter is not as prominent for vowels as for consonants.

Vowel training typically occurs over approximately 5-6 hours of treatment in consecutive sessions. In the first 1-2 hours, because vowels have fewer obvious distinguishing features than consonants, the clinician provides a significant amount of guidance to explore the properties of each vowel. This guidance evolves over time into Socratic questioning with more client-led exploration.

Once all vowels have been introduced, this knowledge should be reinforced by putting the vowels in VC syllables with the "brother" consonants. The "cousin" consonants may also be used, but they tend to change the nature of the vowel (e.g., nasalizing the *o* in *om* vs. *op*) so are less clear and may be more difficult for some clients. To begin introducing VCs, start with one vowel and move from consonant to consonant. Once you have gone through all of the consonants, have the client repeat the vowel in isolation 5 times and then move to another vowel. Note that this process will create some real words (e.g., *ich* is pronounced as 'itch' and *ash* looks and is pronounced like 'ash'). This is not a problem;

just treat them as you would any other phoneme sequence, with no focus on the semantic aspects of the word).

## Suggested tasks for reinforcing single phonemes

Once a phoneme has been successfully introduced, it is important to reinforce that phonological knowledge across tasks and modalities. As described earlier relative to Figure 2, this is done through a variety of perception and production tasks, which may be used in combination. The object is to have each task isolate one modality, or link a stronger with a weaker modality (if you haven't already, this would be a great time to review the section on incorporating multiple modalities in PMT before proceeding). As such, each task can be described, and should be implemented, based on its input and output modalities, as demonstrated in Table 3.

*Table 3 – Examples of treatment tasks by input and output modalities*

| | | Output | | | | | Stimulus analysis and judgment tasks |
|---|---|---|---|---|---|---|---|
| | | Verbal | Visual – Mouth pictures | Visual – Grapheme tiles | Visual – Writing | Blocks and/or Felt squares | |
| **Input** | **Acoustic** | - Repetition<br>- Elision ("Say *bis* without *b*")<br>- Auditory discrimination tasks (e.g., parsing, blending) | - Clinician says a sound or sequence, client finds corresponding mouth picture(s) | - Clinician says a sound or sound sequence, client finds corresponding grapheme tile(s) | - Clinician says a sound or sound sequence, client writes corresponding grapheme(s) | - Clinician says a sound or sound sequence, client identifies corresponding number and color of blocks / felt squares | - Listen to two sounds or sound sequences and determine if they are the same or different, if they rhyme, or if they are real words or not. The visual modality can be included or not based on whether the client can see the clinician's mouth during production. |
| | **Visual – Orthographic** | - Clinician shows a grapheme or grapheme sequence, client says the corresponding sound(s) | - Clinician shows a grapheme or grapheme sequence, client finds the corresponding mouth picture(s) | - Translation to PMT orthography: Clinician writes a real word in standard spelling and client uses tiles to spell using PMT orthography (e.g., jeans → *jeenz*) | - Translation from PMT orthography: Clinician shows a sequence in grapheme tiles that would be pronounced like a real word, client writes the corresponding real word (e.g., *jeenz* → jeans) | - Clinician shows a series of grapheme tiles that create 1 or more syllables, client identifies the corresponding number and color of blocks / felt squares | |
| | **Visual –Mouth pictures** | - Look at a mouth picture (or series of them) and say the corresponding sound(s) | | - Look at a mouth picture (or series of them) and select the corresponding grapheme tile(s) | - Look at a mouth picture (or series of them) and write the corresponding grapheme(s) | | |

NOTE: These are just sample tasks defined by basic input-output relationships. In reality, any given task may merge several input and output modalities, depending on the client's strengths, weaknesses, responsiveness to cues, and current level of success.

Examples of common single phoneme tasks include:

- **TASK:** Listen to and watch the SLP say a sound and select the correct sound from an array of mouth pictures or on the vowel circle. This array will get larger as the client has more trained phonemes.
  **PRIMARY PURPOSE OF TASK:** To build understanding of the relationship between speech sounds and mouth movements.

Input

Visual

Orthographic    Acoustic

Motor    Tactile kinesthetic

Output

Visual

Orthographic    Acoustic

Motor    Tactile kinesthetic
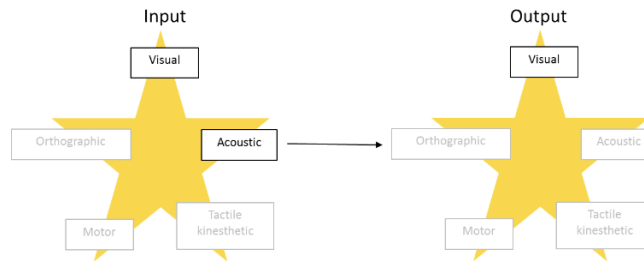
- **TASK:** Listen to and watch the SLP say two sounds and determine whether they are the same or different from each other.
  **PRIMARY PURPOSE OF TASK:** To develop the ability to discriminate between speech sounds.

Input

Visual
(If client can see clinician's mouth)

Orthographic    Acoustic

Motor    Tactile kinesthetic

Output

Visual

Stimulus analysis and judgment – no specific output modalities targeted.

Orthographic    Acoustic

Motor    Tactile kinesthetic
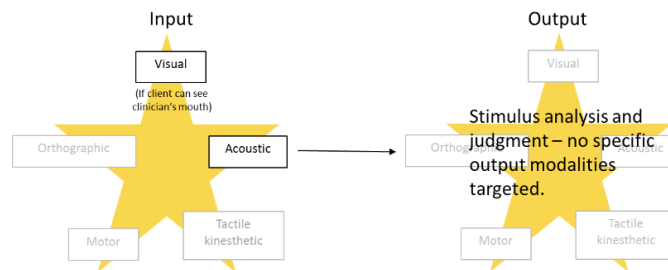
- **TASK:** Listen to the SLP say a sound and select the appropriate grapheme. This task will be used only later in the treatment program, once grapheme tiles have been introduced (see section below on Introducing orthography). Variant: have them match graphemes to mouth pictures.
  **PRIMARY PURPOSE OF TASK:** To strengthen connections between speech sounds and orthography.

Input

Visual
(If client can see clinician's mouth)

Orthographic    Acoustic

Motor    Tactile kinesthetic

Output

Visual
(Mouth pictures)

Orthographic
(Grapheme tiles)    Acoustic

Motor    Tactile kinesthetic
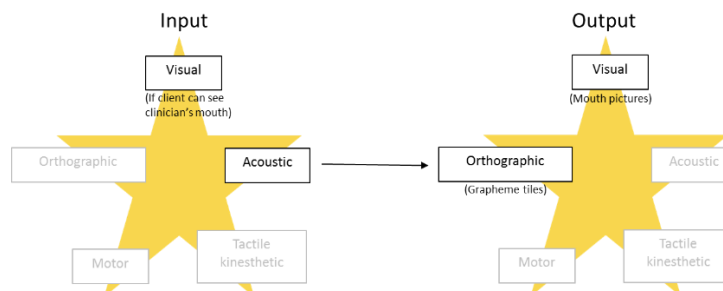
- **TASK:** Sound repetition
  **PRIMARY PURPOSE OF TASK:** To strengthen connections between speech sounds and their associated motor movements.

Input

Output

Visual

(If client can see clinician's mouth)

Orthographic    Acoustic

Motor    Tactile kinesthetic

(Through Socratic questioning to analyze stimulus)

Visual

(If client looks in the mirror during production)

Orthographic    Acoustic

Motor    Tactile kinesthetic

(Through Socratic questioning to analyze response)
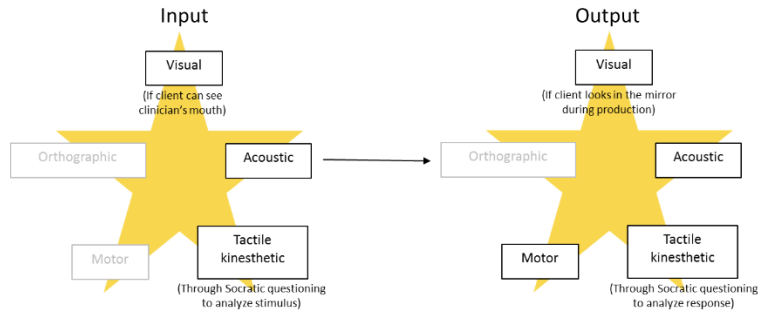
- **TASK:** Produce a sound in response to a mouth picture (with voicing icons, as appropriate)
  **PRIMARY PURPOSE OF TASK:** To strengthen connections between motor movements and production of speech sounds.

Input

Output

Visual

Orthographic    Acoustic

Motor    Tactile kinesthetic

Visual

(If client looks in the mirror during production)

Orthographic    Acoustic

Motor    Tactile kinesthetic

(Through Socratic questioning)
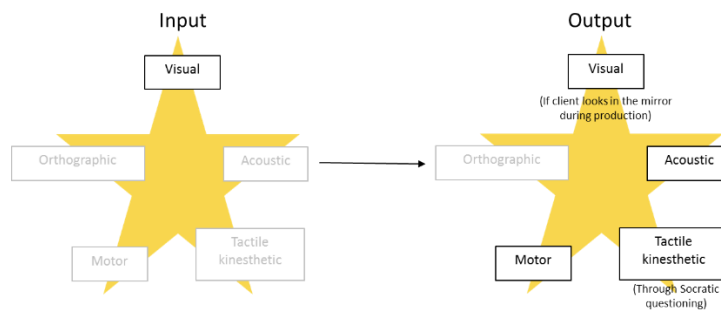
- **TASK:** Produce a sound in response to a description of a motor pattern (e.g., a noisy sound with your lips popping apart)
  **PRIMARY PURPOSE OF TASK:** To encourage explicit awareness of the motor movements involved in speech sound production.

Input

Output

Visual

Orthographic    Acoustic

Motor    Tactile kinesthetic

(Through verbal description)

Visual

Orthographic    Acoustic

Motor    Tactile kinesthetic
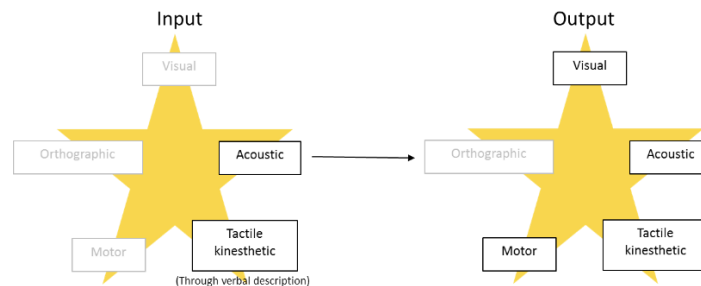
- **TASK:** Produce a sound in response to a written grapheme (after orthography has been introduced)

**PRIMARY PURPOSE OF TASK:** To strengthen connections between orthography and speech sounds.
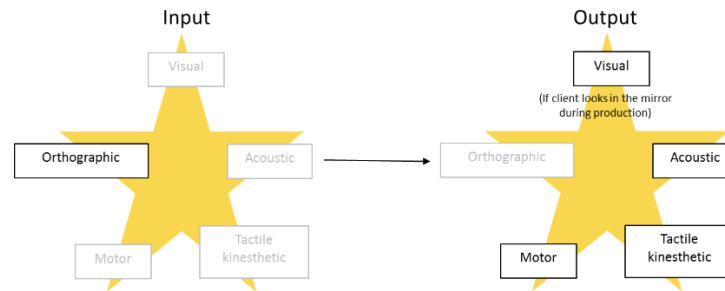


In each of these tasks, Socratic questioning should be used to encourage analysis of stimuli (particularly if an error was made) and assessment of client responses.

You can watch examples of introducing, practicing, and reinforcing single phonemes at https://canvas.uw.edu/courses/1166215/pages/video-examples-introducing-and-practicing-single-phonemes.

## Training sounds in combination

Once a phoneme has been well established in isolation, across a variety of single-phoneme tasks, activities should be introduced that implement and reinforce that phoneme in progressively longer, more complex contexts, such as combining and manipulating phonemes in sequences. As tasks become more difficult and longer phoneme strings are introduced, the same fundamental principles used for single phoneme training are maintained, such as Socratic questioning and pairing weaker with stronger modalities. A few new tools (colored blocks, felt squares) are also introduced later in treatment, to represent the more complex sound combinations in a concrete way (you can read more about these tools in the next section, Suggested tasks for training sounds in combination). When a client has difficulty with a task, you may revert to the same kinds of questions or tasks used during single-phoneme training (e.g., Are your lips moving? Is it a quiet sound or a noisy sound?) to get them back on track with individual phonemes and then incorporate that single phoneme knowledge more strongly at the syllable level. Training beyond single phonemes begins with single syllables (VC, CV, CVC, CCVC, CVCC) and then progresses to multi-syllable items.



As explained earlier, PMT was designed to focus on phonology, with the goal of improving phonological processing and phonologic-semantic connections across the entire language network, in all domains, rather than to train specific words. As discussed earlier, the treatment primarily employs non-words to allow clients to focus on phonology without assistance from their preserved semantic knowledge. Real words are incorporated once syllables have been introduced, however, to strengthen the links between phonology and semantics for the sake of maximizing treatment effects on functional language use. Please see the section on Introducing real words for additional details and explanation.

It is important to note that you will begin working on sounds in combination for some phonemes, particularly those introduced first, while still training at the single-phoneme level with others. The one exception is that all individual phonemes (consonants and vowels) should be introduced before you begin with multi-syllabic stimuli and tasks.
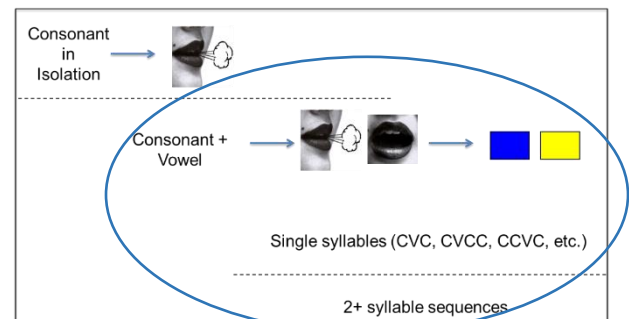
You can see examples of tasks involving sounds in combination in single syllables at https://canvas.uw.edu/courses/1166215/pages/video-examples-introducing-and-practicing-single-syllables, and in multi-syllable stimuli at https://canvas.uw.edu/courses/1166215/pages/training-sounds-in-combination.

## Suggested tasks for training sounds in combination

As with single-phoneme tasks, every task that involves sounds in combination can be described, and should be chosen, based on its input and output modalities (see Table 3). Tasks for sounds in combination may include one syllable or multiple syllables, keeping in mind (as mentioned earlier) that multi-syllable stimuli should not be used until all individual phonemes have been introduced. Examples of common tasks for sounds in combination include:

- **TASK:** Listen to the SLP say a sound sequence and choose all of the mouth pictures that occur in the sequence.
  **PRIMARY PURPOSE OF TASK:** To reinforce individual phoneme knowledge in the context of permissible sound sequences and increasing short-term memory demands.
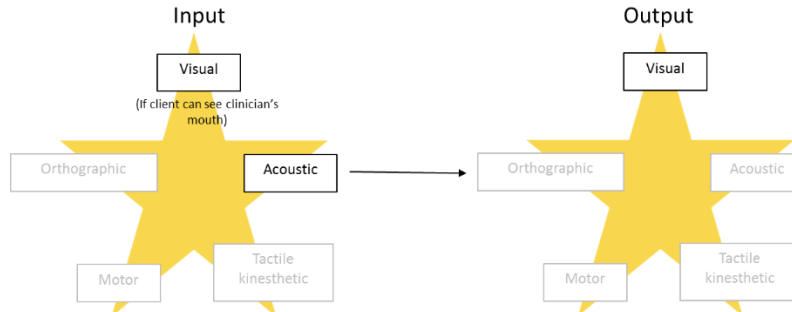


- **TASK:** Listen to the SLP say a sound sequence and lay out the corresponding grapheme tiles.
  **PRIMARY PURPOSE OF TASK:** To reinforce the association between phonemes and graphemes in the context of permissible sound sequences and increasing short-term memory demands.
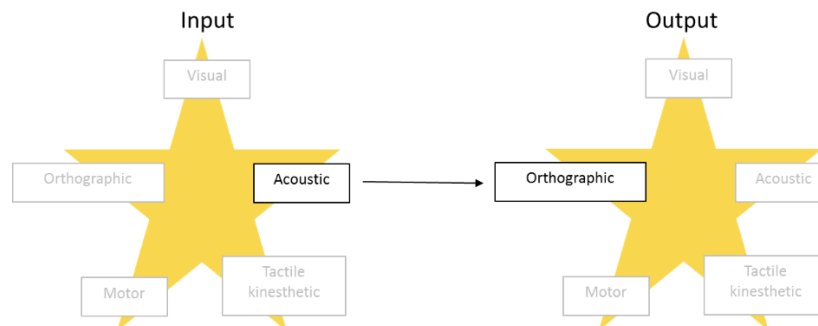


- **TASK:** Sound or syllable chains - Listen to the SLP say a sound sequence and lay out colored blocks to represent the different sounds[4]. In this task, it does not matter which color

[4] Before beginning tasks that use blocks, the clinician should introduce the idea that each block represents a sound. This is done by placing a colored block on the table and saying a single sound. You then remove the block

represents which sound; however, if the same sound occurs more than once in a sequence (e.g., *bebee*), it should be represented by using blocks of the same color in that sequence (e.g., *bebee* could be represented by the block sequence red-yellow-red-green). Once an initial sequence is on the table, the clinician can ask the client to manipulate the blocks to represent different sound combinations (e.g., *ib* to *ish*; less difficult) or present a new sequence (e.g., *ib* to *eef*; most difficult). For instance, a less difficult task of manipulating the sequence already present would be:

- o If that says *bebee*, make it say *febee* (client would change the red block for another color not already in use)
- o If that says *febee*, make it say *feb* (client would remove the green block)
- o If that says *feb*, make it say *fub* (client would swap the yellow block for another color not already in use)
- o If that says *fub*, make it say *fuboo* (client would add a different color block on the end)

**PRIMARY PURPOSE OF TASK:** To provide practice manipulating phonemes in the context of phoneme sequences with increasing working memory demands.
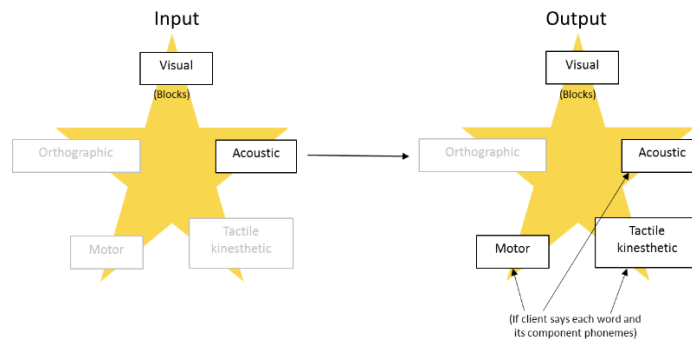


- **TASK:** When stimuli begin to include more than one syllable, an extra layer is added to tasks. The colored felt squares are used to represent syllables (generally described in PMT as "beats"). Introduction of syllables is the only task in the program that purposefully deviates from the proscribed trained word lists. Typically syllables are introduced using familiar one syllable real words, then spondees (e.g., 'hotdog', 'mailman', 'baseball', etc.), followed by 2-syllable real words. The initial real words used are not necessarily from the list of proscribed words but, after the initial introduction of the concept, practice should move to using these words. Once the task has been established with real words, non-words from the proscribed list should be included.
    - o Before introducing 2-syllable stimuli, these squares are introduced as follows:
        - ▪ Explain that words have beats.
        - ▪ Say a one-syllable target (e.g., 'cat') and tap the table one time as you say it, and have the client do the same.
        - ▪ Say a two-syllable target (e.g., 'baseball') and tap the table two times, once with each beat. Have the client do the same.

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and put out either the same block or a different block with a different sound. Continue doing this for 4-5 trials until the client understands that each block represents a sound. If needed, you can explicitly state that each block represents a sound, and that a block might represent a different sound every time it comes out.

- ▪ Provide a few more one- and two-syllable targets and have the client tap out the number of beats in each one, providing assistance as needed.
- ▪ Show the felt squares and explain that they are used to show how many beats a word has.
- ▪ Put one felt square on the table, and tap it as you say a one-syllable target. Have the client do the same.
- ▪ Put down a second felt square to the right of the next one (from the client's perspective), and tap the two in sequence as you say a one-syllable target.
- ▪ Have the client practice tapping out one and two syllable targets as you say them.
- ▪ Once this is well established, introduce placing the blocks on top of the felt squares, with the blocks from each syllable on the appropriate square.

You can see examples of this process at https://canvas.uw.edu/courses/1166215/pages/video-examples-introducing-and-practicing-multi-syllables.

- **PRIMARY PURPOSE OF TASK:** To establish understanding of syllabic structure as part of phoneme sequence knowledge.
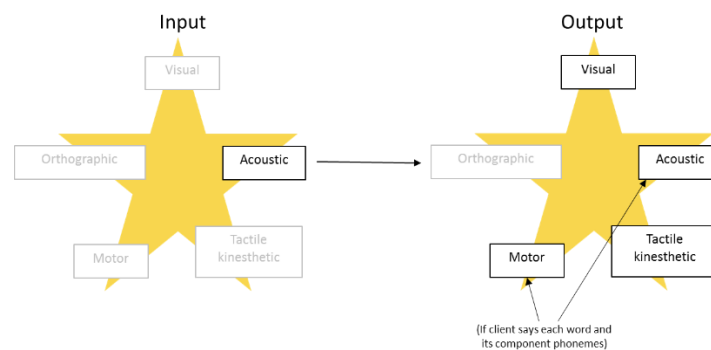


- **TASK:** Sound sequence repetition (single- or multi-syllable)
  **PRIMARY PURPOSE OF TASK:** To strengthen connections between sound sequences and their associated motor movements, with increasing short-term memory demands.
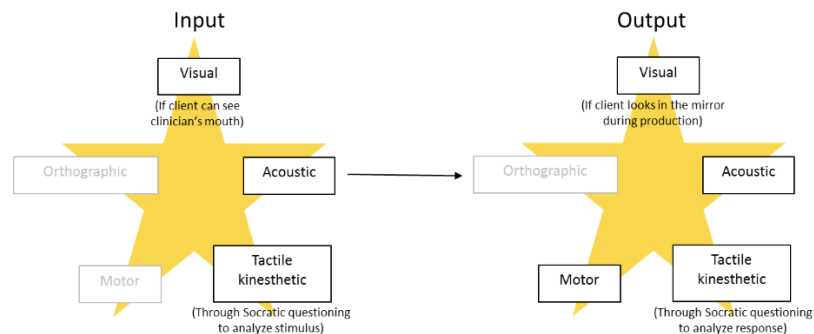


- **TASK:** Produce a sound sequence in response to mouth pictures

**PRIMARY PURPOSE OF TASK:** To strengthen connections between motor movements and production of speech sounds in the context of sound sequences.

Input

Output

Visual

Visual

Orthographic          Acoustic

Orthographic          Acoustic

Motor          Tactile kinesthetic

Motor          Tactile kinesthetic

(Through Socratic questioning to analyze response)
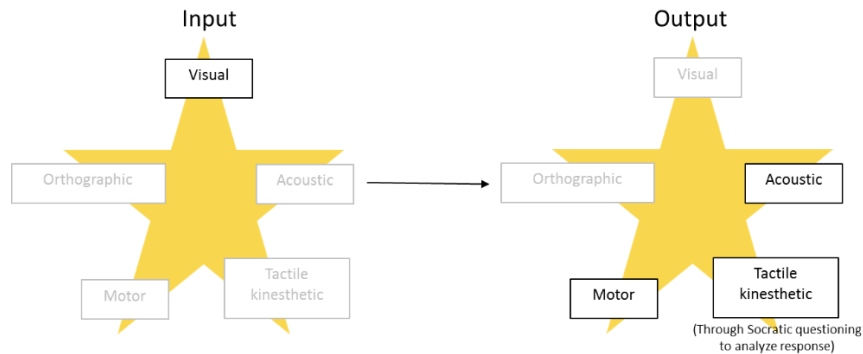
- **TASK:** Produce a verbal sound sequence in response to a written sound sequence (non-word or real word written in PMT orthography; only after orthography has been introduced)
  **PRIMARY PURPOSE OF TASK:** To reinforce grapheme-phoneme associations in increasingly complex sequences.

Input

Output

Visual

Visual

Orthographic          Acoustic

Orthographic          Acoustic

Motor          Tactile kinesthetic

Motor          Tactile kinesthetic

(Through Socratic questioning to analyze response)
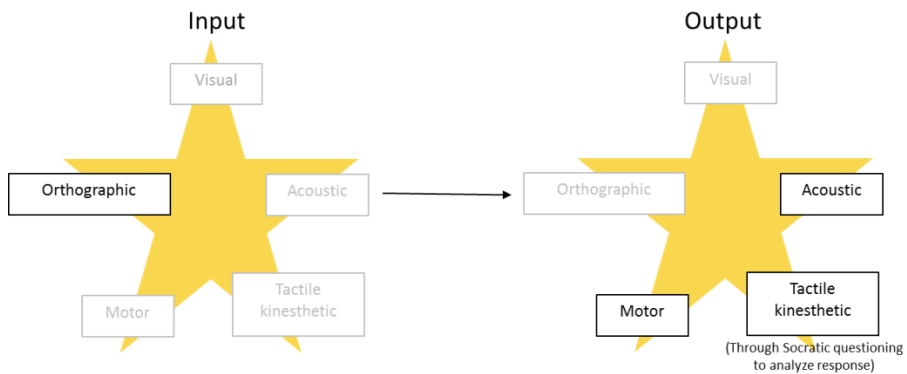
- **TASK:** Listen to the SLP say a sound sequence, and break it down (parse it) into its component phonemes, either verbally or with colored blocks, grapheme tiles, or mouth pictures.[5]
  **PRIMARY PURPOSE OF TASK:** To increase awareness of individual phonemes in the context of complex sound sequences and increasing short-term memory demands.

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[5] Pro tip: This task can be made more complex by using multi-syllable stimuli. The same is true for blending and elision tasks.
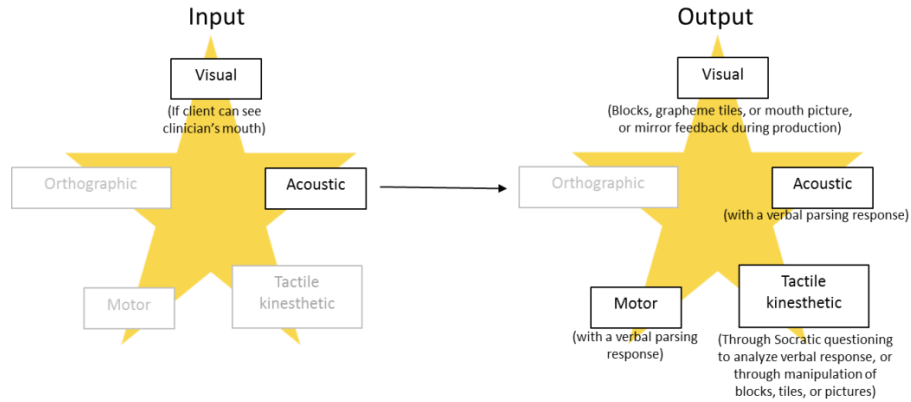
- **TASK:** Listen to the SLP say two or more separate phonemes and blend them together to form a multi-phoneme sequence, either verbally or with colored blocks, grapheme tiles, or mouth pictures. Input could also be written letters or grapheme tiles rather than verbal.
  **PRIMARY PURPOSE OF TASK:** To increase awareness of, and facility with, forming sound sequences.
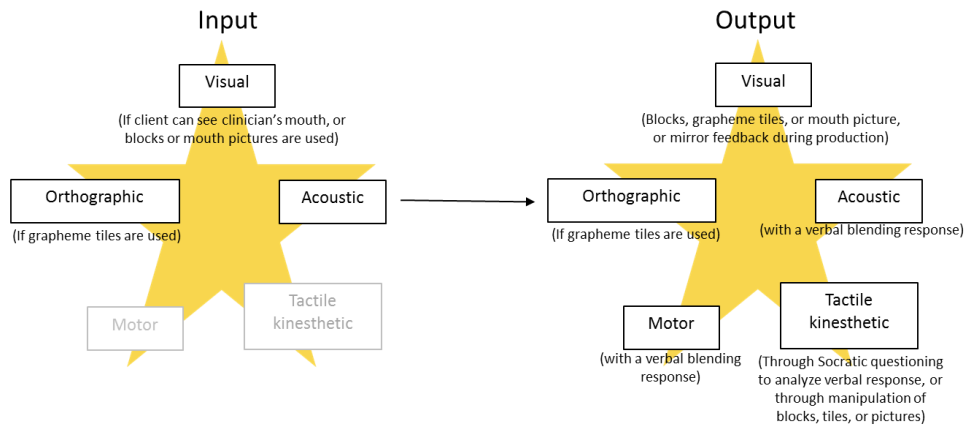


- **TASK:** Elision - Clinician provides a target syllable and the client produces that syllable without a given phoneme (e.g., "Say *bis* without saying *b*"). Note: This task relies heavily on verbal working memory and is best reserved for higher level participants. It may be done with real-word or non-word stimuli.
  **PRIMARY PURPOSE OF TASK:** To provide practice with phoneme manipulation in the context of sound sequences and increasing working memory demands.

Input    Output
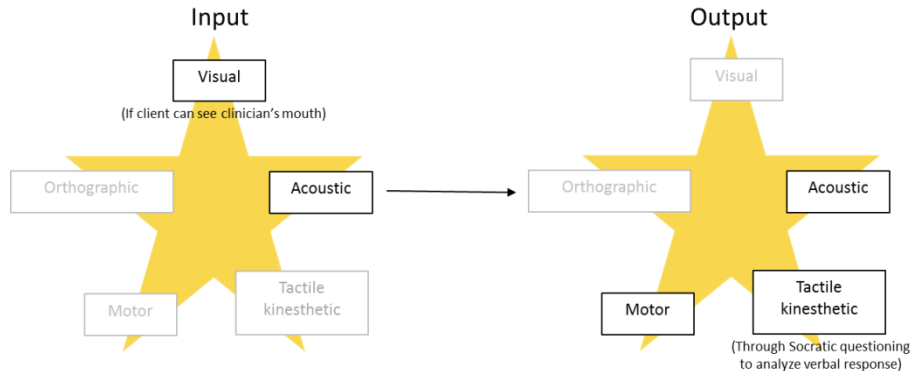
- Complex verbal working memory tasks:
  - **TASK:** Syllable comparisons and transitions (you can see examples of this task at https://canvas.uw.edu/courses/1166215/pages/video-examples-introducing-and-practicing-multi-syllables) –
    - Clinician provides a target word (or non-word) and asks the client how many sounds are in the word.
    - The client lays out the correct number of colored blocks (and grapheme tiles for a lower level client)
    - The client then produces the target, parses it, blends it back together for 3 repetitions.
    - The same sequence is then repeated for a second target word that differs from the first one on a single phoneme (e.g., *peef* and *peeg*), while keeping the blocks/grapheme tiles from the first stimulus in view.[6] The clinician uses Socratic questioning as needed to draw the client's attention to the relevant changes and facilitate accurate productions.
    - Once both sequences have been established, the clinician facilitates having the client move between the two targets, using this format (NOTE: the clinician should not say the two target words again; the client must rely on their own memory throughout this task):
      - The clinician says "tell me the two words" (Client says *peef*, *peeg*)
      - "Now touch and say the old word" (Client physically touches each block of the old word as they parse it (*p, ee, f*) and then scans their finger across the whole set as they blend it (*peef*).
      - "Now touch and say the new word" (Client physically touches each block of the old word as they parse it (*p*, *ee*, *g*) and then scans their finger across the whole set as they blend it (*peeg*).
      - "So you take out ___" (Client responds with *f*, indicating which sound was removed from the first word)

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[6] Pro tip: Typically, this task would be done without any memory supports because it is intended to push the boundaries of working memory. If you have a low level client for whom you think it would be beneficial, though, you may add in supports initially and then fade them over time. For example, you can do a whole sequence of this task with support (letter tiles or pictures or both) and then repeat the entire sequence with those supports removed.

- "And you put in ___" (Client responds with *g*, indicating which sound is new in the new word)
- "Now tell me the new word" (Client says *peeg*)

▪ As a final step, the clinician may remove letter tiles, if present, and have the client reconstruct the words.

**PRIMARY PURPOSE OF TASK:** To integrate and synthesize phoneme and phoneme sequence knowledge, and independence in phoneme manipulation, in a highly complex verbal working memory task.
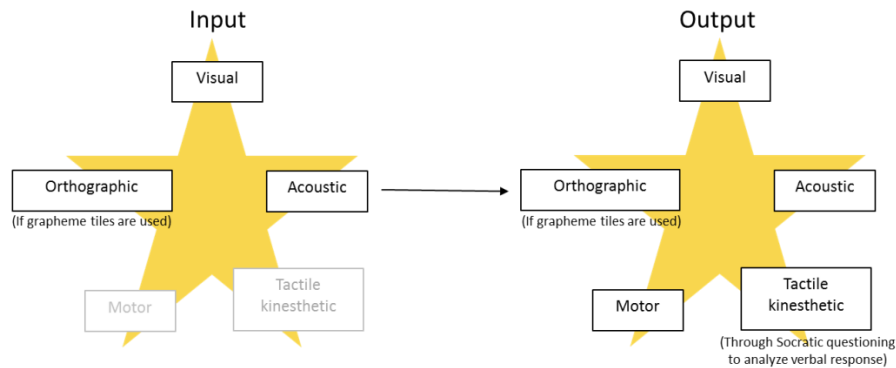


o **TASK:** Syllable transposition – Clinician provides two syllables and asks the client to reverse them. This could be designed such that the client's production is a real word (e.g., *bee-bae → baebee* ['baby'] or a non-word (e.g., *fee-tae → taefee*). Felt squares and grapheme tiles may be used to provide visual cues as needed.

**PRIMARY PURPOSE OF TASK:** To practice manipulation of phoneme sequences (rather than individual phonemes) in a complex working memory task.
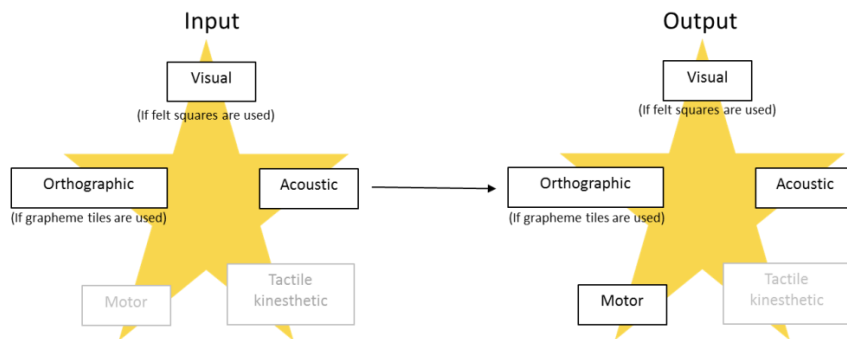
## Anatomy of a treatment session

Every treatment session after the first one (see above for details of that session) should begin with a 5 minute warmup to give some initial success, re-establish the task mindset, and reinforce skills that have already been learned. This warmup time may include a variety of tasks that the client has already completed successfully, including repetition, matching of sounds to mouth pictures, or saying sounds associated with the various mouth pictures.

Early in the treatment program, many clients benefit from actually setting up the mouth picture and vowel tile stimuli in their ordered arrays (see Figure 16 and Figure 17 for the complete mouth picture arrays without and with graphemes, and Figure 18 for a sample complete workspace setup); this task helps to reinforce the properties, similarities, and differences of the individual phonemes and phoneme groups. While some clients are able to lay out the entire array independently in just a minute or two after they're familiar with it, others will need more help to do it in a reasonable time. This task can be scaled back to meet individual needs by providing partial information or structure, such as laying out the sound group labels that they've drawn (see Figure 15), providing the anchor vowels on the vowel circle (see Figure 14), or having them lay out only a portion of the items independently after you have set up a number of them already. As the client progresses in the program and there is less of a focus on the mouth pictures, this initial setup may be faded.
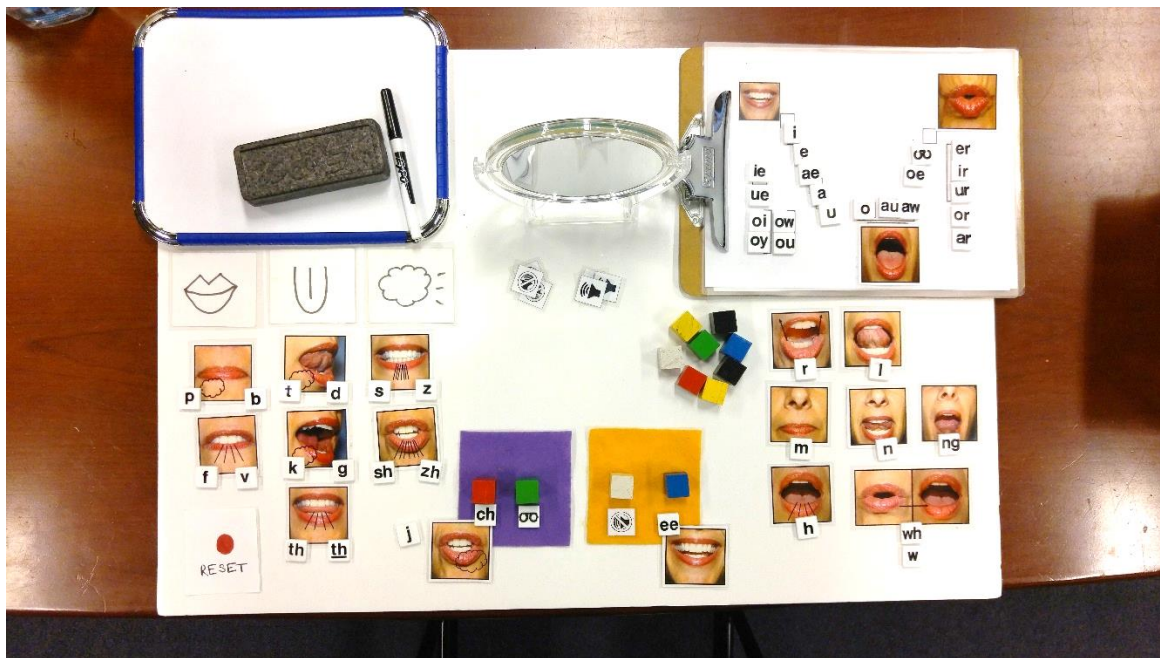


*Figure 18 - Complete desktop workspace for a task using multi-syllable stimuli.*
*Note that the blocks and felt squares are the primary manipulative for the task being introduced, but all tools, including pictures, vowel tiles, and mirror, are within view to be used as needed.*

Within the bulk of a session, the exact structure will differ from participant to participant (the case studies provided at the end of this manual highlight the wide variety of forms that treatment sessions can take). Some people do well with extended periods of time working on a single task, while others benefit most from frequent changes of activity. For instance, one participant may do well doing a long period of one production task and then a long period of one perception task, while another may be

more comfortable and successful with going back and forth multiple times between production and perception tasks. The exact content of any given session (i.e., which tasks to do and which phonemes to target) will be based on a variety of factors, including the syllable length and complexity they are ready for, their abilities with blocks vs. letters, and what skills they're struggling with vs. strong with. Each session should end with a few minutes of a task on which the client is likely to be successful. Keep in mind that the goal of treatment is to improve phonologic awareness and phoneme sequence knowledge, so whatever tasks are used (perception, production, orthography, etc.) will work toward that goal.

## Anatomy of a treatment trial – merging tasks within a single trial

Unless you are working on isolating a single phoneme or element, a single treatment trial generally intersperses multiple tasks that reinforce the knowledge being learned and manipulated. For instance, in a syllable chain task in which the client is asked to change a sequence of blocks from representing *babee* to representing *fabee* (described earlier), the clinician may use Socratic questioning to have the client explain the change that they made (e.g., "Which sound changed between words? ["The first sound"] … "What parts of the mouth do you use for the new sound?" ["Lips and teeth"] "Point to the mouth picture/letter that goes with the new sound."). The clinician may then ask them to parse the new word into syllables and/or sounds (e.g., "What's the new word? [*fabee*] … Tell me each syllable in the new word [*fa… bee*] … Tell me each sound in the new word." [*f…a…b…ee*]). Then the clinician may have them blend the sounds back together to bring them back to the full word before presenting the next stimulus in the sequence.

This combination of tasks and levels of processing can and should be done at nearly every level of treatment once the initial phonemes are introduced. Doing so links all domains of language representation (i.e., visual, acoustic, orthographic, motor, and tactile kinesthetic), a fundamental goal of PMT.

## Introducing orthography

As described earlier, for people who have learned to read, orthographic knowledge is fundamentally embedded in the lexical network, heavily connected with phoneme knowledge. For some people with aphasia, orthography remains a relatively preserved modality, so they are able to use orthography to support phoneme retrieval. For these people, orthography should be introduced relatively late in the program, after a phoneme has been trained in isolation and is being used in combination. This will allow the client to focus on the information carried by other modalities to build strong phoneme representations without relying on orthographic knowledge. *This may feel counterintuitive, as most aphasia treatment encourages relying on stronger modalities to assist with functional communication. In this case, though, it can interfere with the goal of treatment, which is to strengthen weaker modalities.* Other people with aphasia have poorly preserved orthographic knowledge. These people may benefit from introducing orthography earlier in the program so that orthographic knowledge can be strengthened concurrently with other modalities.

To determine whether a client has strong or weak orthographic representation, the SLP can do a brief assessment of residual orthographic knowledge early in the treatment program. This assessment may include asking the client to write, or point to the letters that go with a few phonemes, or say the sound (i.e., NOT the letter name) that goes with a letter presented. Again, if someone is weak in orthography, the SLP may choose to introduce the letters earlier in the program; if someone is strong in orthography, letters should be introduced later so that the client can't overly rely on that modality to the exclusion of focusing on others.

Whenever the graphemes are introduced, there are a few options for how to approach this task, and the SLP may use some combination of techniques such as:

- Using Socratic questioning to ask the client which letter goes with a given sound
- Giving the client a letter tile and asking them to place the letter on the corresponding mouth picture (blocking by type of sound, such as lip, tongue, and air sounds).
- Saying a sound and asking the client to write the letter that goes with the sound.

Regardless of the method used to introduce the graphemes, the SLP should show it to them if they do not get it correct initially. As each letter tile is introduced, it is placed on the appropriate mouth picture in place of the "quiet" and "noisy" icons. The letter tiles are then included in all future activities that involve the mouth pictures. The appropriate graphemes can be reinforced across sessions by having the client lay them out at the start of each session.

You can see examples of introducing and using orthography at https://canvas.uw.edu/courses/1166215/pages/video-examples-introducing-and-using-orthography.

## Progression through the task hierarchy

It may help to think of the program as linear, or sequential, for each phoneme but not globally; you may be working on single-syllable tasks for some phonemes while still introducing and establishing some of the individual sounds in single-phoneme tasks (see Figure 5). While PMT presents a hierarchy of stimulus and task difficulty in theory, treatment may not progress directly through this hierarchy. Most clients will be ready to start working with a few early-established phonemes in short syllables while continuing to introduce other individual phonemes. This frequently happens when a client has mastered some phonemes at the single-phoneme level but has not mastered others; the mastered phonemes may be moved into CV tasks before the other phonemes are ready for that progression. *There is one notable limitation to this flexibility in the task hierarchy: all individual phonemes should be introduced and explored before moving a client into tasks that involve multi-syllable stimuli with well-established phonemes*. If only a limited set of phonemes are being trained (see the section on Delivering PMT in the real world – practical considerations), all phonemes that you intend to treat should be introduced before moving on to multi-syllable stimuli. In addition, any given treatment session or task will likely involve cues at many levels of complexity; for instance, a multi-syllable chaining task may involve discussion of the individual phonemes involved as part of the Socratic questioning process.

PMT is a dynamic process; on any given task, the clinician should be responsive to the client's performance. There are many ways to do this; for instance, you may increase task difficulty as they do very well and then scale back when you see that they are starting to have less success, or you may choose a level where they are doing well consistently and then continue at that level until their accuracy declines due to fatigue. See the section on Adjusting task difficulty and facilitating client success for further discussion of this issue.

In general, if the client has no success in the first 4-5 trials with a new task, this indicates that the task is too difficult and the clinician should drop down to a simpler task.[7] If the client has complete success in the first 4-5 trials, this indicates that the task is probably too simple and task difficulty should be increased.  Examples of methods of cueing and manipulations that can change task difficulty are provided in the section on Socratic questioning: A fundamental element of PMT.

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[7] Pro tip: The exception to this is the client who has a hard time acclimating to tasks or shifting task set. These problems are generally evident across tasks, including tasks that you know they can do well, making these clients relatively easy to identify. In their case, before moving to an easier task the clinician should do more than 4-5 trials, or take a break and then re-initiate the new task, to be certain that the client's problems are not just due to task shifting problems.

## Adjusting task difficulty and facilitating client success

In addition to carefully crafting Socratic questions to facilitate client processing, the clinician also needs to consider and adjust task complexity if a client is not having success at a particular level, or is doing particularly well. While PMT is not specifically intended to involve errorless learning, it is important that clients are challenged enough to make progress but not so challenged that they do not experience frequent success. Ultimately, it is the clinician's responsibility to assure that tasks are not too easy or difficult. If a client is making a lot of errors, there is something wrong; the clinician should evaluate the modalities and specific stimuli and tasks being used to find ways to challenge the client while facilitating success.

Tasks can be made more or less challenging by:
- Incorporating and combining more or fewer modalities to support processing. This might include:
    - Adding or removing visual cues (e.g., mouth pictures, blocks, grapheme tiles, or the ability to see the clinician's mouth)
    - Adding or removing writing
    - Adding or removing tactile-kinesthetic descriptions (e.g., "This is the sound that has the top teeth biting the bottom lip and you let air out.")
- Physically manipulating the space between blocks or tiles, particularly in parsing and blending tasks (or removing physical cues, such as blocks or tiles, to make the task more difficult; see Figure 19.)
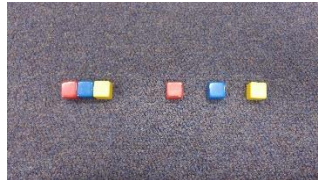


*Figure 19 - Colored blocks spaced for blended vs. parsed sequences
(e.g.,* bif *on the left and* b - i - f *on the right).*

- Increasing or decreasing time between trials - NOTE: For some clients, increasing time between trials provides time for activation to die down, reducing interference and perseveration, making the task easier. For others, increasing time between trials increases the working memory load, making the task more difficult.
- Making the stimulus shorter or longer (in terms of either phonemes or syllables). Note that including consonant blends makes a stimulus more difficult.
- Changing the relationship between contrasting stimuli – phonemes that share phonologic features (e.g., "b" and "g", which share both manner of articulation and voicing) are typically more difficult to differentiate than phonemes that do not (e.g., "b" and "sh") (see Appendix for tables of phonemes that share

- Phonemes with no features shared (differ on 3 features) – Easiest to differentiate, Phonemes with 1 feature shared (differ on 2 features) – Moderate difficulty to differentiate, and Phonemes that share 2 features (differ on 1 feature) – Most difficult to differentiate phonemes). Therefore, making stimuli more similar will typically make the task more difficult, and making them more easily differentiable will typically make the task harder.
  - o When starting to pair vowels with consonants, many people find voiceless consonants easier, likely because of their greater difference from the vowels.
- Adjusting which element within a syllable is changed in a sound chaining task; clients typically find syllable-initial position to be the easiest to manipulate, followed by syllable-final, and then medial position. In addition, many people have more difficulty with changing vowels, particularly if they are in the middle of the syllable.
- Changing the sequence of production, from blocked to random (e.g., once all vowels on the left side of the vowel chart have been introduced, you might have the client work from the top, left corner of the chart down to the bottom of the chart and then back up again; you could then move to having them produce them in random order as you point to the different graphemes).
- Moving between production and perception tasks – which task is easier or harder depends on the individual client.
- Moving to phonemes with which the client has previously had either good success (easier) or more difficulty (harder).
- In chaining tasks, keeping previous stimuli in view (blocks, grapheme tiles, or written) after the string has been changed, so that the client can follow the progression of changes over the course of the task (see Figure 20 and Figure 21).
-
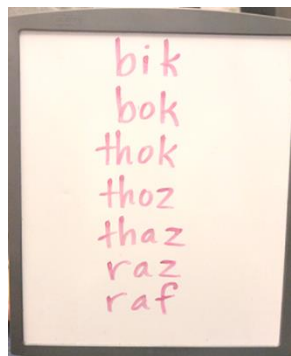


*Figure 20 - One way to keep previous stimuli in sight during a chaining task. The clinician added each item as it was introduced during the task, and then had the client go back through the previous items after introducing each new stimulus, focusing on which element had changed.*
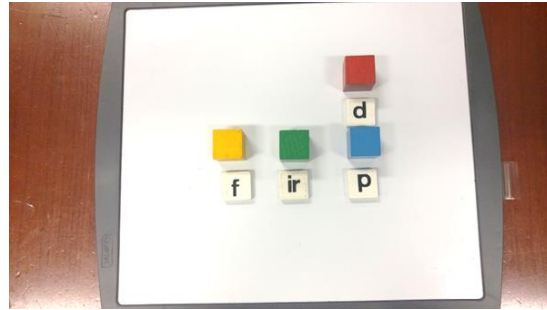
*Figure 21 - A second example of how to keep previous stimuli in sight during a chaining task. In this case, changing from* fird *to* firp*, the blocks and grapheme tiles that stayed the same were moved down, while the old and new changed phoneme remained in sight.*

- Providing more or less physical cueing for a task. For example, if a client is having difficulty learning to parse and blend, this task can be made easier by providing hand-over-hand guidance to demonstrate separation or blending of phonemes (i.e., pointing to each colored block or letter tile individually while saying each in isolation [*f-e-p*], and then running the finger across all blocks/tiles in the word while saying it as a single blended unit [*fep*]). As the client becomes more adept with parsing and blending, the hand-over-hand cues may evolve to the clinician providing visual cues by pointing, having the client point by him/herself, or having the client do the task without visual cues.
- Encourage or discourage verbal rehearsal of target stimuli (e.g., in a complex syllable chain task, in which a client is moving blocks or letter tiles to represent which sound is changing, it is easier if the client verbalizes the stimulus and more difficult if you instruct them not to).
- Shifting between replacing or subtracting single phonemes in a sequence (easier), adding phonemes to a given sequence (harder), and transposing phonemes within a sequence (hardest).

A single treatment trial will likely include multiple forms of questions and cues as you work through both the stimulus presentation and the response.

# Treatment stimuli

## Devising non-word stimulus combinations

During PMT, the clinician comes up with non-word phoneme combinations based on the phonemes being addressed and the task circumstances. The clinician may do this in real time, during the session, or may prepare lists of stimuli ahead of time so that the tasks flow more smoothly in treatment. While any non-word phoneme combination is possible, there are a few guidelines to keep in mind:

- Non-words should be structured in ways that are permitted in English, in terms of their structure and sound combinations. For example, English words cannot start with *zh* or *ng*, or end on *h*, *w*, or the lax vowels *i* or *e*, so non-words used in PMT tasks should follow those same rules. If a client is having a particularly difficult time with a phoneme sequence, consider whether it may include sound combinations or structures that are not permissible in English and adjust accordingly if it does.

- VC combinations are less likely to yield real words than CV combinations (e.g., *ees* and *eeb* vs. *see* and *bee*). For this reason, when working with strings of two phonemes it is often easier to use VCs than CVs.

- There will be times when a real word is accidentally created in the course of treatment, particularly during tasks in which a single element of the stimulus is being switched out to work through all of the vowels or consonants (e.g., using the same consonant and working through all of the vowels in combination with it). This is unavoidable and generally not a problem. When this happens, just recall that these stimuli are to be treated simply as phoneme strings, with the focus remaining on the sounds rather than the meaning. If a client has particular difficulty maintaining a focus on phonology when real words arise (e.g., they perseverate on the real word when the stimulus shifts back to non-words), then consider switching tasks to interrupt the perseveration and returning to the problematic task later, being sure to use only non-words when you return.

Along with all of the non-word phoneme sequences that are created in the moment, studies of PMT effectiveness have included certain non-words used repeatedly and intentionally. These non-words (see Appendix) were devised to have properties (low phonotactic probability and high neighborhood density) that should facilitate learning (Storkel, Armbruster, & Hogan, 2006). They are used in the same way that all other non-words are in this treatment, but with a specific focus on using them repeatedly across tasks and sessions (see Kendall et al., 2015, for a detailed discussion of the rationale for using prescribed non-word stimuli). The clinician should keep track of which non-words are used in each session, and rotate through them all across sessions.

## Introducing real words

### Choice of real words to incorporate into treatment

PMT was designed to focus on phonology, with the goal of improving phonological processing and phonologic-semantic connections across the entire language network, in all domains, rather than to train specific words. As discussed earlier, the treatment primarily employs non-words to allow clients to focus on phonology without assistance from their preserved semantic knowledge. Real words are incorporated once syllables have been introduced, however, to strengthen the links between phonology and semantics for the sake of maximizing treatment effects on functional language use.

This treatment has been tested using a specific set of real words. As described earlier for the non-word stimuli, these words were chosen to have properties (low phonotactic probability and high neighborhood density) that should facilitate learning (Storkel et al., 2006). Because the treatment is designed to generalize across language representations and domains, and based on the model that motivates PMT and research outcomes to date, improvements in functional communication are expected even without specifically training personally relevant vocabulary. To keep clients focused on phonology rather than on semantic and other aspects of stimuli, we do not recommend choosing client-specific real words.

### Introducing and using real words in treatment

Real words are typically introduced late in treatment, frequently as part of tasks that involve parsing, blending, and elision, in pseudo-homophone tasks, and in tasks that use colored blocks to practice swapping out phonemes to create changing strings of stimuli. In these cases, the task may start with a non-word, evolve to a real word, and then evolve back to a non-word. For instance, a task sequence could unfold as follows:

Clinician: Put out blocks to show the sounds in *feeb.*

(Client puts out a red block, a white block, and a green block, in that order)

Clinician: If that says *feeb*, make it say *neeb.*

(Client swaps out the red block for a black block)

Clinician: If that says *neeb*, make it say *nee* ('knee').

(Client removes the green block)

Clinician: If that says *nee*, make it say *neek.*

Regardless of the task, it is important to remember that real words should always be treated as phoneme strings, with the focus remaining on the sounds rather than the meaning.

For real words being used intentionally (see Appendix for the full list of recommended real words, presented in standard orthography and in PMT orthography for reading-based tasks), the clinician should keep track of which words have been used in each session and make an effort to rotate through all of them repeatedly throughout the treatment program.

# Keeping data for PMT

Keeping data for PMT is critical but difficult, as could be expected for any complex treatment. There is not a single way that it must be done, but there are some general principles that can guide your development of a data keeping system that works for you.

In general, it is important to keep data in each session on:

- The input and output modalities of each task.
- The length of stimuli being used (single sounds or sounds in combination).
- The consistency of the position being manipulated in a string of sounds (e.g., if you are doing constant or random practice).
- The amount of cueing needed (e.g., minimal, moderate, maximum) and examples of the types of cues used (e.g., looking in the mirror, repeating before pointing to a stimulus, etc.).
- How accurate the client was on the task (given the parameters described by the previous items).

It is also useful to have a place to document general observations about each session, and to keep a record of which sounds have already been trained and mastered at which level (in isolation, syllables, and blends). This information could be maintained on a separate reference sheet that stays in the client's chart, or could be incorporated into your data sheets. Having this information readily available will make it easier for you to keep track of what level to address with each sound from session to session, and will provide critical information for a therapist who cover a session if you are not available.

A few blank data sheets are provided in Sample Data Sheets; you will see that they are quite different from each other, with some being more structured and others being less structured, but each reflects a system that has worked for a clinician experienced with PMT. Some of the demonstration videos provided also have completed data sheets provided as examples. In addition, some clinicians find it useful to record data during the session (typically at the end of each task, rather than during the task, since tasks typically require high levels of clinician engagement), and others make their notes at the end of the entire session. We encourage you to experiment with different data-keeping formats, and establish one that works for you.

## Delivering PMT in the real world – practical considerations

As with any treatment approach, the decision to use PMT with a particular client should be based on information from all three pillars of evidence-based practice: the best available research evidence, your own clinical expertise, and your client's preferences. This perspective requires you to incorporate a wide variety of factors such as your own level of comfort and skill with PMT, the amount of time you have available for treatment, and your client's abilities and priorities. While research is continuing to explore and validate a variety of practical modifications to PMT, there are not yet data available to directly inform all possible circumstances, such as limited treatment time or intensity; therefore, we can only speculate at this point in time about options for modifying PMT to meet individual needs. In the meantime, we encourage you to take a translational approach, determining how best to take the currently available evidence and apply it to your clinical setting. With all of this in mind, there are a number of questions frequently asked about the logistics and practicality of using PMT:

**FAQ #1:** All of the PMT data are from programs that lasted 60 or 96 hours. There's no way I could provide that many hours of treatment to one client! How can I implement PMT when I don't have that many hours to devote to it?

**Response to FAQ #1:**

While all of the published research on PMT has involved at least 60 hours of treatment (i.e., program duration) at high intensity (i.e., frequency and length of individual sessions), we recognize that it can be difficult or impossible to match those parameters in most clinical settings. If your client appears to be a good candidate for PMT, the language models that motivate PMT (see What is Phonomotor Treatment (PMT)?) suggest that the tasks used in PMT could be helpful, due to their multi-modal focus on phonology, even if all sounds are not specifically trained. Remember: the goal of PMT is to train phonological awareness, not necessarily the entire inventory of sounds in the language. You might start with the treatment package as described and decide, as you go along, what to prioritize based on client performance. For instance, you could specifically train just a sampling of the phonemes in the early stages, to establish the ability to think about individual sounds in multi-modal terms, but then use all sounds in treatment tasks. Alternatively, you could choose to train all phonemes in a cursory manner, just making sure that they understand how to explore sounds in a multi-modal manner before moving on to syllable-length tasks. These approaches would mean that treatment tasks are implemented in less of a step-wise manner than has been tested, but would still incorporate all of the basic elements of PMT.

With all that said, and consistent with the available literature on treatment effects in aphasia (Robey, 1998), we suggest that PMT sessions should occur at least twice weekly. In addition, due to the number of activities involved in PMT, and the time it can take to work through the Socratic questioning process with each stimulus, we do not suggest sessions shorter than 45 minutes. Even with 45-50 minute sessions, treatment time should be highly focused to maximize work time, with little to no socializing. All of this is supported by review of the aphasia treatment literature, which suggests that greater treatment intensity leads to greater improvement in language skills (Raymer et al., 2008).

**FAQ #2:** All of the PMT data are from programs that have provided treatment two hours per day, 5 days per week. What if I can only see my clients one or two times each week, and my sessions are only 50 minutes long?

**Response to FAQ #2:**

PMT has not yet been tested at a lower intensity, such as one hour per day a few times per week. We are currently planning a research trial to address this question. The models on which PMT are built predict that positive outcomes should still be possible with lower intensity. If you choose to implement PMT at a lower intensity or frequency than has been tested, we suggest beginning treatment at relatively high intensity and frequency (e.g., 3 one-hour sessions in the first week), to allow you to quickly determine if a client is a good candidate, and then reducing the intensity or frequency once this has been confirmed. In our experience, if a client is still struggling with understanding the task format for learning single phonemes after 3-4 hours of treatment, and is not showing signs of

being able to take what has already been learned and apply it to new stimuli as they are introduced, they may not be a good candidate for PMT. Note that this assessment does not rely on response accuracy on treatment tasks, but is related more to whether the client demonstrates conceptual understanding of the tasks and cues and can actively participate (e.g., see Case study #4: Lynn). If they do not at this point, it would be appropriate to consider a different treatment approach.

**FAQ #3:** This is a really complex program. What are the critical elements that I need to be sure are maintained if it doesn't seem to be a perfect fit for my client in all respects?

**Response to FAQ #3:** The only non-negotiable elements of PMT are multi-modality manipulation of phonemes in progressively longer strings and the pervasive use of Socratic questioning. Both of these are essential to developing phonological awareness, which is the ultimate goal of the program. Despite its complexity, the multi-faceted nature of PMT means that there is quite a bit of flexibility in how the program is implemented. The clinician can, and should, adjust every task to meet each client's unique combination of strengths and weaknesses. For example, the clinician may selectively manipulate the modalities being paired in a task, the modalities focused on in Socratic questioning, or the response modalities used. The clinician may also choose to alter some of the conceptual organization of the stimuli; for instance, after initially introducing all of the consonants in the groupings described here (i.e., lip, tongue, and air sounds, which combine place and manner of articulation), some clients benefit from discussing or grouping the sounds in terms of just one category of phonological feature. For instance, some people find it easier to think about stop consonants versus continuants, while others find place of articulation to be a more helpful organization scheme. So long as treatment remains focused on multi-modality phonological awareness and uses Socratic questioning, you are working within the boundaries and guidelines of PMT.

**FAQ #4:** When should my client be discharged from treatment?

**Response to FAQ #4:**

The question of when to discontinue treatment is a difficult one, and will depend on a combination of factors such as client progress, motivation to continue treatment, and availability of treatment resources (e.g., insurance coverage and clinic schedule). In terms of client progress, which is the factor best addressed here, it is useful to think about the skills that the client has gained to date.

The research literature on PMT demonstrates that many people who have completed the program as tested (i.e., 60 hours of treatment in 6 weeks) continue to improve in language skills for at least a year after treatment ends. This is predicted by the parallel distributed processing model on which this treatment is built, which describes the language processing system as a complex, multi-modal network; once established, the network connections are self-reinforcing through exposure to everyday language use. To facilitate this continued growth of language skills after treatment ends, we suggest that treatment continue at least until the client has solidified a majority of phonemes (consonants and vowels) and developed some skill with sequence manipulation (rather than just working at the single-phoneme level).

We do believe that people who respond well to PMT could potentially benefit from continuing indefinitely. As long as they are continuing to make progress and have not yet hit the limits of typical performance (as measured by the clinician's ability to process the stimuli and tasks), treatment tasks can continue to be made progressively more difficult. There may be no maximum treatment duration. At the same time, however, continuous treatment is often not feasible, whether because of funding, client commitments, or changes in treatment priorities. If continued treatment is not feasible or desired, it is possible to discontinue treatment and then arrange for the client to return for reassessment at some future date and determine if they could benefit at that time from another short course of treatment, to either reinforce previously learned skills or to realize new gains.

**FAQ #5:** My client really wants homework to do on the days she doesn't come in for therapy. What kind of homework can I have my PMT client do?

**Response to FAQ #5:**

Because PMT is such a multi-layered, complex treatment, and it is not advisable to have clients practice things incorrectly, we do not recommend having clients practice specific PMT treatment tasks at home. You can, however, encourage them to do tasks that reinforce phonological awareness and processing. These could include:

- Reading aloud (Dr. Seuss books and some forms of poetry are particularly good for highlighting and manipulating phonology);
- Listening to audio books while following along with a print version;

Record strings of stimuli in an elision task (e.g., *aerplaen* without *plaen* is *aer*; *chootee* without *tee* is *choo*; see the

## Vowel Progress Chart

| | Isolation | | Combination | |
|---|---|---|---|---|
| | Introduced/In progress | Mastered (>80% indp) | Single syllable | Multiple syllables |
| | | | | |
| ee | | | | |
| o/aw/au | | | | |
| oo | | | | |
| | | | | |
| i | | | | |
| e | | | | |
| ae | | | | |
| a | | | | |
| u | | | | |
| oe | | | | |
| uu | | | | |
| | | | | |
| er/ir/ur | | | | |
| or | | | | |
| ar | | | | |
| | | | | |
| ie | | | | |
| ue | | | | |
| oi/oy | | | | |
| ow/ou | | | | |

| Sounds in ISOLATION Progress Chart | | | |
|---|---|---|---|
| | | | |
| | *Supported* | *Independent* | |
| | Introduced/In progress | Perception | Production |
| p | | | |
| b | | | |
| f | | | |
| v | | | |
| t | | | |
| d | | | |
| k | | | |
| g | | | |
| th | | | |
| <u>th</u> | | | |
| s | | | |
| z | | | |
| sh | | | |
| zh | | | |
| ch | | | |
| j | | | |
| l | | | |
| r | | | |
| m | | | |
| n | | | |
| ng | | | |
| h | | | |
| w/wh | | | |
| | | | |
| ee | | | |
| o/aw/au | | | |
| oo | | | |

| Sounds in ISOLATION Progress Chart | | | |
|---|---|---|---|
| | *Supported* | *Independent* | |
| | Introduced/In progress | Perception | Production |
| | | | |
| i | | | |
| e | | | |
| ae | | | |
| a | | | |
| u | | | |
| oe | | | |
| uu | | | |
| | | | |
| er/ir/ur | | | |
| or | | | |
| ar | | | |
| | | | |
| ie | | | |
| ue | | | |
| oi/oy | | | |
| ow/ou | | | |

## Sounds in COMBINATION Progress Chart

| | Single syllables | | Multiple syllables | |
|---|---|---|---|---|
| | Simple | Complex | Simple | Complex |
| p | | | | |
| b | | | | |
| f | | | | |
| v | | | | |
| t | | | | |
| d | | | | |
| k | | | | |
| g | | | | |
| th | | | | |
| th | | | | |
| s | | | | |
| z | | | | |
| sh | | | | |
| zh | | | | |
| ch | | | | |
| j | | | | |
| l | | | | |
| r | | | | |
| m | | | | |
| n | | | | |
| ng | | | | |
| h | | | | |
| w/wh | | | | |
| | | | | |
| ee | | | | |
| o/aw/au | | | | |
| oo | | | | |

## Sounds in COMBINATION Progress Chart

|  | Single syllables | | Multiple syllables | |
|---|---|---|---|---|
|  | Simple | Complex | Simple | Complex |
| i |  |  |  |  |
| e |  |  |  |  |
| ae |  |  |  |  |
| a |  |  |  |  |
| u |  |  |  |  |
| oe |  |  |  |  |
| uu |  |  |  |  |
|  |  |  |  |  |
| er/ir/ur |  |  |  |  |
| or |  |  |  |  |
| ar |  |  |  |  |
|  |  |  |  |  |
| ie |  |  |  |  |
| ue |  |  |  |  |
| oi/oy |  |  |  |  |
| ow/ou |  |  |  |  |

## Data Sheet: Sounds in Combination

| Date | Input (circle) | Output (circle) | Level (e.g., CV, CVCV, # syllables), Position (e.g. initial/medial/final) and Cueing used | Accuracy (+/- or % correct) |
|------|----------------|-----------------|-------------------------------------------------------------------------------------------|------------------------------|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

### Key

- = speech
- = mouth pictures
- = mouth descriptions
- = letter tiles
- = writing
- = colored blocks
- = colored felts

- Glossary of Terms) and have them passively listen to them;
- Simple phoneme, real word, and non-word repetition tasks using combined audio-visual stimuli that you record on their phone or iPad;
- Listen to lists of word pairs and judgments on whether or not they rhyme.

There are also some relevant defined treatment programs that lend themselves to independent practice:

- Copy and Recall Treatment (Beeson, Rising, & Volk, 2003);
- The National Aphasia Association has a list of available apps for aphasia therapy: www.aphasia.org/aphasia-resources/aphasia-apps/. Some of these apps reinforce phonological skills, including letter to sound matching, same/different judgment on minimal pairs, reading aloud, sound identification, sound matching, spoken rhyming, word copying, and word repetition.

This is not an exhaustive list, and we encourage you to use your creativity and knowledge of phonological awareness to develop tasks that are appropriate for your client. Just keep in mind that the overarching goal is phonological awareness, and tasks should ideally allow practice without a high risk of error.

**FAQ #6:** How do I decide if I should do PMT or some other type of therapy with my client?

**Response to FAQ #6:**

As with any intervention, the decision whether to use PMT should be made after considering client priorities, abilities, and practical circumstances. If a client's highest priority is verbal communication, you have identified that they have phonological processing impairments, and they already have a system in place for basic daily communication, then PMT may be a great way to address this goal. If a client's priority is functional communication, however, regardless of the amount of difficulty they're having with verbal communication and acquired alexia, then PMT may not be the best treatment choice for them.

If a client is interested in balancing both restorative and compensatory treatments, consider whether you can use treatment time for PMT to address restorative communication goals and train family members, caregivers, or friends to support compensatory communication goals outside of treatment. The balance of treatments may also change over time; you may start with more word-based and compensatory treatment approaches as you establish basic communication systems early in treatment and build rapport, and then explore doing PMT on a trial basis. In this case, you can explain that you believe this is an appropriate treatment

Note that PMT is not appropriate for acute care settings. These settings tend to lack the intensity needed for PMT, and there are likely other, higher priority treatment objectives at that early stage.

**FAQ #7:** It seems like PMT would take a lot of time to learn to do it well. I only see people with aphasia occasionally. Is it worth my learning PMT?

**Response to FAQ #7:** PMT is a complex approach to treatment, and there is definitely a steep learning curve. Once it is learned, though, it is very flexible and can be used with people with aphasia at all levels of severity. If you only see a few people per year with aphasia, though, you may decide it is not worth investing the time and energy to become skilled in this treatment approach. In this case, we would encourage you to refer clients who are appropriate candidates for PMT to another SLP who carries a larger caseload of people with aphasia and is trained to use PMT.

**FAQ #8:** I'd love to have some support as I learn and implement PMT. Is there a way to be in touch with other SLPs who are using PMT?

**Response to FAQ #8:** We have established a discussion board on the PMT training website (https://canvas.uw.edu/courses/1166215/discussion_topics), where clinicians can exchange ideas. If you would like to participate in the online discussion group, please send an email request to aphasia@uw.edu with either a University of Washington email address or a Gmail address and we will arrange for you to have access to the group.

In addition, you can hear two individuals who received intensive PMT discuss their experiences with this treatment program at https://canvas.uw.edu/courses/1166215/pages/client-perspectives-on-pmt.

# Case studies

## Case study #1: Morgan

**Case description:**

Age: 62

Time post-onset: ~2 years

Diagnosis: Aphasia subsequent to left CVA

Language profile:

- Verbal production:
  o He speaks in complete sentences with accurate grammatical structure, with primarily anomic errors characterized by frequent omissions and phonemic paraphasias.
  o He is aware of his production errors in speech, and attempts to repair them when they occur and is almost always able to do so.
  o He benefits from phonemic cues if he is unable to find a word himself.
- Comprehension:
  o His auditory comprehension is good for complex, novel information in a quiet environment, but breaks down in the presence of distraction.
  o He is generally aware when he has not understood something and asks for clarification as needed; this happens infrequently, typically when he is tired.
- Other:
  o He has no dysarthria or apraxia of speech.
  o He is highly motivated and engaged in the treatment process.

**Socratic questioning with Morgan:** Morgan has very good auditory comprehension and excellent insight and self-awareness. He tends to notice small relevant details, at a level that is generally reserved for trained clinicians, and is capable of doing high level analysis as a result. For instance, during exploration of vowels, he is aware of fine differences in tongue position (front/back, high/low) and can apply this awareness to describing and distinguishing the phonemes. Socratic questioning with this client can begin fairly open-ended, and can involve complex questions. For example, in later stages of treatment the clinician might say two CVC words (e.g., *feep* and *feesh*) aloud with no supporting visual stimuli, and the client would likely be able to explain the difference between the two targets and identify the corresponding mouth pictures and graphemes.

**Single phoneme training:** When the first sound pair is introduced, he quickly catches on to the types of information being asked for, and tunes in to the various characteristics and properties of the sounds with little cueing. After the first sound pair is introduced, he applies the training protocol to future sound pairs so he learns them quickly, with little direct questioning (e.g., he addresses the topics of the Socratic questions that he'd been led through with *p/b* as he explores *f/v*). He needs only a few rounds of structured practice with each consonant cognate pair for both production and perception before successfully moving into random practice conditions, and needs little drill practice to differentially produce vowels after they are initially introduced. He retains knowledge and skills across sessions and days. He is quickly successful taking on independent management of treatment materials, such as sorting consonant mouth pictures into categories, arranging grapheme tiles on the vowel circle, and matching grapheme tiles to the mouth pictures.

**Sounds in combination:** In general, this client moves through the progression of tasks very systematically. He readily progresses from high to low levels of cueing and from highly contrastive to

minimally contrastive pairs (e.g., initially contrast *fip-foop* and then move to *fip-fep*). At times, the clinician increases task difficulty or reduces cueing faster or in larger steps than she might typically use because she senses that he is able to handle it. In tasks that combine sounds, he is quick to implement his knowledge from single-phoneme training to analyze and correct errors that he makes (e.g., he says *fip* for *fap*, and then describes that his jaw was not open enough). Even when the clinician is not asking Socratic questions, he often talks about his processing in these analytical terms while he's working to process a stimulus or task. Tasks typically involve single modalities, as he does not need the support of multiple modalities to achieve high levels of success. He carries over information well between tasks and from session to session. Despite his overall high levels of performance, he often becomes overloaded as his cognitive resources for a task he's been doing well with seem to become depleted; clinical observation suggests that this is due to a build-up of interference over time. On these occasions, he becomes perseverative, shows increasing phonemic errors in production tasks, and has poor accuracy in perception and discrimination tasks. As a result, he benefits from switching tasks frequently, when the clinician notes that errors are becoming more frequent. In addition to this decline in performance over time, it is also noted there are behavioral management issues that interfere with task performance; at times, he is overenthusiastic and gets himself confused as he attempts to over-analyze stimuli or do more than the task at hand requires. In these cases his performance also suffers, but he is generally successful getting back on track with a cue to take a short break and "reset" and then resuming the task at hand, rather than switching tasks.

**Outcomes and next steps:**
- Overall assessment: Morgan has been an ideal candidate for PMT.
- Status after several weeks:
  - He is moderately to very successful (though not yet 100% accurate) manipulating complex, multi-syllabic stimuli across many tasks and modalities, such as:
    - 2-syllable non-word repetition with no visual cues;
    - reading aloud CCVC and CVCC strings in a random presentation sequence;
    - sequencing mouth pictures and felt squares to auditory input at the level of CVCVC strings.
  - He continues to have significant difficulty with complex phonological working memory tasks, such as identifying the phonemic change in a chaining task and maintaining it through a series of Socratic questions about the old and new targets without additional auditory models from the clinician.
  - Repeated standardized language testing reveals that he has improved on confrontation naming, auditory comprehension, reading, and communication efficiency and effectiveness in discourse, and his overall disability scores have improved.
  - In conversation, he shows fewer instances of anomia (omissions), fewer phonemic paraphasias, and more efficient repairs when word retrieval breakdown occurs.
  - He reports several functional changes:
    - He has been able to resume activities at home that involve significant linguistic working memory load (e.g., working with his wife to build planter boxes, in which she gives him complex instructions that he needs to process and retain long enough to execute).
    - He can now read newspaper articles and understands them on the first reading, whereas he had previously needed to read articles 2-3 times to fully understand.

- He is still somewhat limited in writing emails, keeping them shorter than he would have liked, but he reports that his wife now makes fewer edits to them, suggesting that they are more accurate and effective than previously.
- Given what has been demonstrated in the research on PMT, this may be an appropriate point to discharge him from treatment because:
    o his confrontation naming and discourse skills are now only minimally impaired, and are meeting most of his daily needs, and
    o he has received 60 hours of treatment and the literature suggests that many clients reach a plateau after that much treatment.
- However, it may also be appropriate to continue treatment because:
    o he continues to be engaged and interested in therapy,
    o he has areas of language use that he would like to continue developing, and
    o he has the resources available to continue treatment
- If treatment continues:
    o it could continue to focus on increasing stimulus complexity and abstraction, with a particular focus on the domains most difficult for him: writing and verbal working memory.
    o Treatment might also branch out to include more functional tasks (such as writing emails), with an emphasis on using strategies and skills developed in PMT to support his success.

## Case study #2: Phil

**Case description:**
Age: 62
Time post-onset: ~4 years
Diagnosis: Aphasia subsequent to left CVA
Language profile:
- Verbal production:
    o He produces grammatically complete sentences, characterized by frequent anomic episodes and use of non-specific language.
    o He often uses sound effects, intonation, and gestures to help convey his ideas.
    o He often recognizes when he makes in errors in verbal production, but does not often try to fix those errors. When he does try, he is generally unsuccessful and is typically unable to retrieve words that he is missing, even when he takes extra time.
    o When he takes extra time to look for a word, he often loses track of the message he was trying to convey, indicating impaired working memory.
    o He only occasionally benefits from phonemic cues, and does not benefit from semantic cues.
- Comprehension:
    o His auditory comprehension is good for single words and highly familiar or contextualized information. His comprehension benefits from repetition, rewording of the message, supplemental gestures, and keyword writing at times.
    o His reading comprehension is only fair, with frequent semantic confusions noted.
    o He frequently recognizes when he has not understood a message, but does not always ask for clarification.
- Other:
    o He has no dysarthria or apraxia of speech.

**Socratic questioning with Phil:** Because of Phil's impaired auditory comprehension, he cannot manage open ended questions as well as Morgan. Instead, he does best with short questions and a limited field of response choices. For example, when exploring the *p* sound the clinician presents drawings with key words (e.g., see Figure 7) and asks, "What's moving?". Because of his impaired self-monitoring and error awareness, he often needs significant support to analyze and correct responses. For example, if the clinician says *eep* in a repetition task and he responds with *eesh*, he may not accurately identify that the two productions do not match. The clinician would then structure Socratic questions to take him through analysis of each modality, with frequent reminders and control of timing of response presentation to accommodate his WM impairments. This exchange might look like this:

> Clinician: Close your eyes and just listen – *eep* - *eesh*… are they the same?
> Phil: No.
> Clinician: Now look at me and watch my mouth… *eep* - *eesh*. Did they look the same?
> Phil: No.
> Clinician: Watch my lips at the end. e*ep*… did my lips pop at the end?
> Phil: Yes.
> Clinician: *eesh*… did my lips pop at the end?
> Phil: No.
> Clinician: So that's how they were different. *eep* had my lips popping open and *eesh* didn't. Now try to repeat after me – *eep*.
> Phil: *eep*.
> Clinician: Do they match?
> Phil: Yes.
> Clinician: Did your lips pop at the end?
> Phil: Yes.
> Clinician: Yep, they did. Both of us popped our lips at the end, so they matched.

**Single phoneme training:** On introducing consonants, he cannot explain mouth movements due to poor articulatory motor awareness; even when provided visual supports (e.g., written words 'lips', 'teeth', 'tongue', watching the clinician, and looking in the mirror) he requires maximum cueing to identify which articulators are engaged. This continues after many hours of practice. Adding letter tiles does not help but the clinician decides to keep the letter tiles present as an attempt at engaging and strengthening orthographic representations in the course of the phoneme learning process.  To build his articulatory awareness, the clinician has him watch her, repeat what she says, judge whether they sound the same, and then has him look in the mirror and judge whether they look the same. She then covers her mouth and has him repeat the target again while watching in the mirror and deciding if they sound the same. He has greatest success in single phoneme training with judging whether his productions match a clinician model and, if it does, producing/repeating the sound 5 times consecutively. If his productions don't match, the clinician begins Socratic questioning to identify errors and attempts to produce the correct target, but there is no consistent pairing of modalities that is notably helpful and the clinician often ends a trial with just telling him what the answer is and having him try to repeat it again. He is not successful in learning to differentiate vowels in any kind of explicit way; vowels are engaged primarily through simple repetition tasks.

**Sounds in combination:** As task complexity increases, his articulatory motor awareness remains poor, so the clinician continues to engage the same types of strategies as in single-phoneme tasks. In perception tasks, he generally needs to have small fields of choices; his performance degrades significantly if there

are more than 3-4 options, and he is only successful with that many choices if he had already had a significant amount of practice with the target in isolation immediately before the more complex task. Using single letters neither helps nor hinders his performance, but full written words and non-words generally improve his performance. This relative strength is used at times by overlaying strings of letters on strings of mouth pictures or blocks for an initial trial, and then removing them and having him complete the trial again. Blending tasks are particularly difficult for him, as he needs to add just a single element at a time (e.g., rather than blending *m-i-p* to say *mip*, he produces/repeats *m*, then *mi*, then *mip*), so these tasks are more like chaining tasks than blending. Initially when increasing task difficulty by increasing phoneme string length (e.g., going from CV to CVC targets) the clinician only asks him to identify where in the string the change is taking place, and then writes in the accurate letter or selects the appropriate mouth picture for him. As he gets better with identifying the location of the changed phoneme, she makes the task more difficult by having him identify where the change occurs and select the changed element from a field of two widely contrastive choices (e.g., *z* vs. *p*). Overall, Phil does better with many trials of just a few tasks per session.

**Outcomes and next steps:**
- Overall assessment: Phil has been a good candidate for PMT.
- Status after several weeks of treatment:
  - repeated standardized testing indicates that Phil has improved in naming and auditory comprehension, although his reading and disability scores have not improved.
  - He is continuing to progress through the treatment program, with gradually increasing accuracy for progressively more complex tasks.
  - He continues to be motivated and has the resources available to continue therapy.
  - For all of these reasons, it would be appropriate to continue treatment with him and re-assess his progress after another 5-10 hours of therapy to determine if he has reached a plateau or is continuing to make gains.

## Case study #3: Suzanne

**Case description:**
Age: 70
Time post-onset: ~2 years
Diagnosis: Aphasia and apraxia of speech subsequent to left CVA
Language profile:
- Verbal production:
  - Her verbal output is severely limited, characterized by single word utterances that are slow, with prolonged phoneme durations, lengthened inter-syllabic durations, and phoneme distortions, indicating a concomitant apraxia of speech.
  - She has fair-good awareness (60-75% of the time) when she makes errors in verbal production.
  - She is frequently frustrated by her limited verbal output.
  - She is particularly frustrated with her consistent inability to say the name of the daughter with whom she lives.
  - When she recognizes incorrect verbal productions, she often tries to correct them but is typically not successful.

- o She does not typically benefit from phonemic cues, and can only repeat a given word approximately 50% of the time on the first or second attempt when it is provided to her after a word retrieval failure.
- Comprehension:
  - o Her auditory comprehension is good for short, familiar sentences.
  - o Her comprehension benefits from repetition, supplemental keyword writing, and drawing.
  - o She has good recognition of when she has not understood a message, and asks for clarification as needed.
- Other:
  - o She has no functional reading or writing ability.

**Socratic questioning with Suzanne:** Her awareness of stimulus characteristics is best in highly structured tasks with multimodality stimulus cues and maximal difference between stimuli (e.g., few shared features). Most of the time, she needs very specific yes/no questions (e.g., "Was your voice on for that sound?") along with multimodality cues (e.g., having her hand on her neck to feel for vocal fold vibration). She is unable to respond to open-ended (e.g., "Tell me about that sound.") or forced choice questions (e.g., "Is that sound noisy or quiet?").

**Single phoneme training:** During exploration of sounds, she cannot independently describe mouth movements due to extremely limited verbal output. Her independent production of consonant sounds based on visual input (e.g., pointing to a mouth picture) is approximately 30% accurate, mostly with quiet sounds. The only vowels she can independently produce and perceive are the anchor vowels (*ee*, *oo*, *aw*). Even though she doesn't have a lot of sounds she can produce independently, her repetition for single phonemes is approximately 70% accurate, though with apraxic distortions. In treatment, her relatively stronger skills are engaged in a variety of ways. She can accurately point to stimuli that represent the various aspects of phoneme production (e.g., category labels for lips, teeth, and tongue, "quiet" and "noisy" icons, etc.), so this response modality is used often to explore how sounds are made. In addition, combined auditory and visual input (e.g., listen to the clinician, watch the clinician, watch herself repeat the sound in the mirror) are used to develop knowledge of the mouth pictures and their corresponding phonemes, which increases her success to approximately 80%. Finally, because her grapheme-phoneme correspondence knowledge is poor, so she does not use printed letters as a crutch, the letter tiles are introduced early in her program to provide additional support to her processing networks.

**Sounds in combination:** She has difficulty switching between tasks, struggling at first when a new task is introduced; once a task is established, however, she tends to have good success over many trials. Therefore, the clinician chooses not to vary tasks much **within** a session; instead, she does many trials of just a few tasks. In more difficult repetition and parsing sequences (e.g., CCV), Suzanne has a hard time blending the consonants in non-words, although she is generally successful if the blends are in real words. The clinician chooses to take advantage of this by putting target phoneme combinations into real words and then doing elision tasks to remove the extra phoneme and create a non-word (e.g., elicit accurate production of *smok* ('smock') and then have her "say *smok* without the *k* " to produce the non-word *smaw*).

**Outcomes and next steps:**
- Overall assessment: Suzanne has not been an ideal candidate for PMT at this point in time, but has benefitted to some degree.

- Status after several weeks of treatment:
    o Suzanne is approximately 80% accurate on CVC repetition tasks, with independent parsing of the sounds given auditory and orthographic input.
    o In VC chaining tasks (e.g., "if this says *eeb* make it say *ib* "), she is most successful with changing just the vowel sound from trial to trial, a relatively low level version of the task.
    o In tasks using auditory input paired with watching the clinician's mouth, she achieves ~60% accuracy identifying sound changes in a random condition using a combination of felt squares, colored blocks, pictures, and letters for CVCV structures (e.g., *chootee → gootee → gooter*), and is getting better at independently parsing out the sounds.
- Repeated language testing shows modest improvements in picture naming, but no changes in reading, auditory comprehension, and only minimal improvement in overall disability scores.
- In conversation, she continues to be very anomic and apraxic, with speech output still generally limited to single words, but she is now coming up with more accurate vocabulary during spontaneous speech.
- For comprehension, she requires less support from her conversation partners in the way of gestures and supplemental key word writing.
- Functionally, she is usually using the right name for her daughter (with whom she lives) as compared with 0% accuracy at the start of treatment.
- Because her improvement with PMT is slow, and she has expressed that she would like to focus more on establishing functional communication, it is appropriate to discontinue PMT. The clinician might:
    o discharge her from treatment, with recommendations to her family regarding how to continue to support her functional communication needs (she has indicated that she may be interested in returning to PMT at a later date as her skills and priorities change), or…
    o keep her enrolled in treatment but shift the focus to compensatory strategies or direct training of specific functional verbal vocabulary.
        ▪ If the clinician chooses to work on functional verbal vocabulary, some of the cueing strategies established in PMT may be incorporated to support this work.


## Case study #4: Lynn

**Case description:**
Age: 70
Time post-onset: ~6 years
Diagnosis: Aphasia subsequent to left CVA
Language profile:
- Verbal production:
    o Her verbal output is typically grammatically correct but characterized by anomia.
    o When she has an anomic episode, she is generally aware of it, gets frustrated, and abandons the message with few attempts at repair.
    o She has frequent stereotypic phrase production such as, "Oh honey, you're so sweet" or "Oh honey, you're so pretty."

- Comprehension:
  o Her auditory comprehension is good for familiar or contextualized short information.
  o She benefits from having messages reworded, although she often gets anxious about not having understood the original message.
  o She has fair-good awareness when she does not understand a message, but will not ask for clarification; instead she will respond with "I don't know."
- Other:
  o She has a prolonged history of depression and anxiety disorder.
  o She typically refuses tasks if she does not think she will be successful with them.
  o She does not like working with nonsense words.

**Socratic questioning with Lynn:** Despite her reasonably good auditory comprehension, Lynn has a very hard time with Socratic questioning for a few reasons. Her anxiety makes her defensive nervous about being wrong, leaving her feeling like she is being attacked when errors are pointed out. This is compounded by her inability to understand that Socratic questioning occurs whether a response is correct or not. In addition, her poor evaluative skills make it difficult for her to recognize or understand her errors when they occur, and then correct them, even with maximal cueing through Socratic questioning.

**Single phoneme training:** Single phoneme tasks are very difficult for Lynn, although she is willing to work sounds in isolation. Nearly all tasks used are based in repetition, as she is unable to independently produce a sound in response to a description or visual cue, analyze articulator movements, or identify external stimuli (such as mouth pictures or letters) in response to what she hears. She can repeat a single production, but when asked to do ten repetitions of a target she counts from 1-10 instead of saying the target; visual, non-linguistic cues are used successfully to elicit multiple repetitions. She is unable to inhibit reading aloud of the words "quiet" and "noisy" when asked to use the relevant icons to differentiate cognates, although she does better when icons without words written on them are used. The clinician attempts to introduce letters early in the process to support her success, but she cannot inhibit naming the letters, creating interference. She benefits from cues to "reset" when she gets frustrated or perseverative. Vowel training confuses her, as she does not understand the concept of the "ladder" between the vowels, so explicit training of all vowels is abandoned and only the anchor vowels are used. She successfully alternates between consonants in tasks that use sound pairs in random practice conditions (e.g., 10 productions of each, then 5, then alternate, then random), but then cannot resume the task after a break without going through the entire sequence again. This is characteristic of her poor maintenance of knowledge, even within a single session. After 6 hours of treatment, she is 80% accurate identifying sounds presented auditorily with a field of two choices of mouth pictures held up to the clinician's mouth while she says the sound; her accuracy drops below 50% if there are more than two choices or if the mouth pictures are not shown right next to the clinician's mouth. After 11 hours of practice, she has been introduced to most of the consonants. Given her struggles with single phoneme tasks, the clinician concludes that the mouth pictures are too abstract for her, and her inability to inhibit unrelated responses interferes with single sound practice. The clinician knows that it isn't always clear if someone is not a good candidate for PMT, as many people have trouble with the abstract nature of single phoneme tasks; therefore, he decides to move to tasks that use sounds in combination in hopes that the greater context and variety of tasks might yield greater success.

**Sounds in combination:** Lynn gets very frustrated working at the syllable level because the non-words do not make sense to her. Despite multiple explanations she does not understand the rationale for using

them; simply put, she does not h**a**ve buy-in for these activities. In addition, these tasks are very difficult for her, increasing her frustration; the number of stimuli involved are overwhelming so the clinician can present only one visual stimulus at a time, significantly limiting opportunities to link modalities and compare or manipulate contrasting sounds. The colored blocks are too abstract for her, and she is offended to be asked to use a childish toy. She is unable to do parsing tasks, and cannot participate in Socratic questioning beyond making same/different judgments and completing lexical decision tasks. Ultimately, she is only successful with real word repetition and copying tasks, which is not enough for PMT. In addition to her significant language impairments, her participation is also negatively impacted by her depression and anxiety, and possible changes noted in her general cognitive ability.

**Outcomes and next steps:**
- Overall assessment: Lynn has been a poor candidate for PMT
- Status after a few weeks of treatment:
  o She has had poor success with both single phonemes and sounds in combination.
  o She has exhibited significant frustration with treatment, and has not been able to fully engage in treatment activities, including the critical element of Socratic questioning.
  o She shows no evidence of progressing through the treatment hierarchy, or improving in expressive or receptive communication in functional tasks or on standardized tests.
- This treatment approach is discontinued and the clinician chooses to focus, instead, on client and caregiver education and support.
  o Lynn responds well to participating in aphasia groups and having regular lunch dates with another woman with aphasia, so the clinician facilitates her initial involvement with those activities and encourage her family to continue providing these opportunities.

# Appendix

Printable resources for implementing PMT

## Treatment example videos

The video examples referenced throughout the text can be viewed as follows:

**Client perspectives on PMT:**

https://canvas.uw.edu/courses/1166215/pages/client-perspectives-on-pmt

**Pre-treatment conceptual explanation:**

https://canvas.uw.edu/courses/1166215/pages/video-examples-pre-treatment-conceptual-explanation

**Introducing and practicing single phonemes:**

https://canvas.uw.edu/courses/1166215/pages/video-examples-introducing-and-practicing-single-phonemes

**Introducing and practicing multi-syllables:**

https://canvas.uw.edu/courses/1166215/pages/training-sounds-in-combination

**Introducing and using orthography:**

https://canvas.uw.edu/courses/1166215/pages/video-examples-introducing-and-using-orthography

**How NOT to do PMT:**

https://canvas.uw.edu/courses/1166215/pages/video-examples-how-not-to-do-pmt

## Mouth pictures
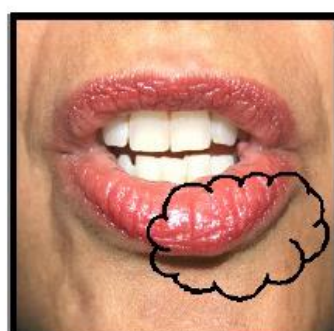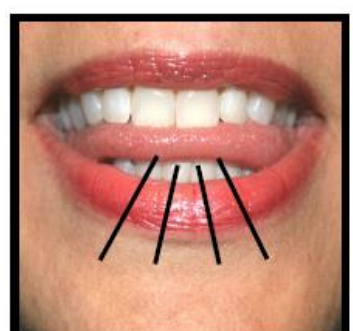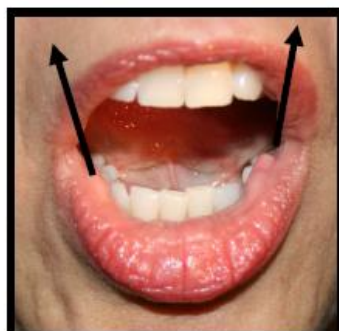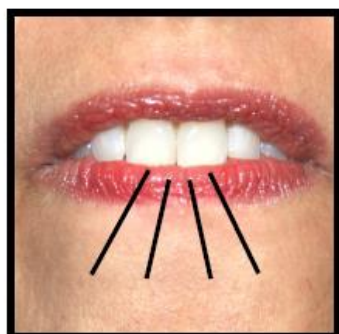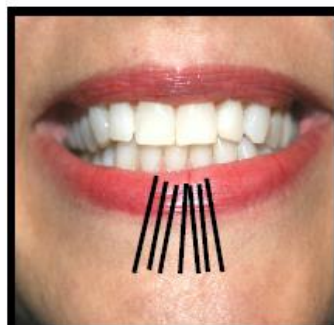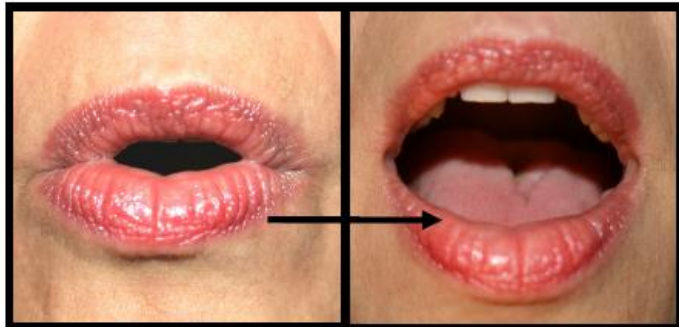
Blank vowel circle for use in therapy sessions
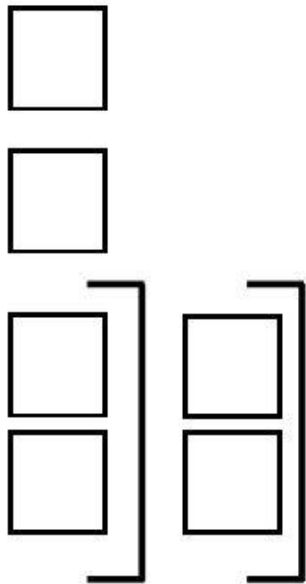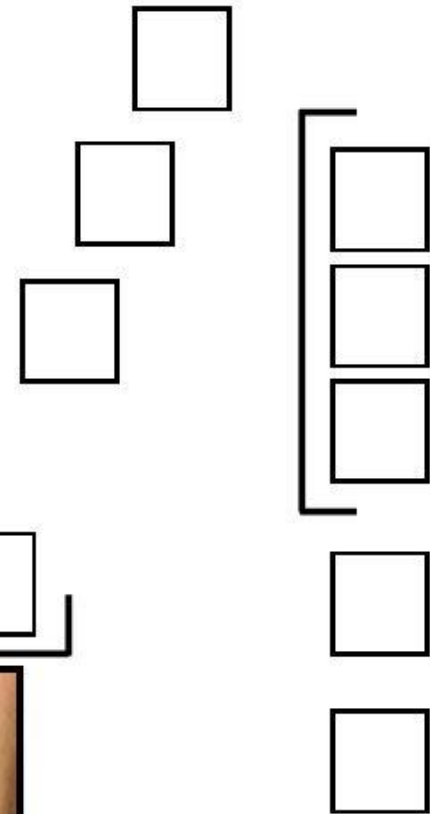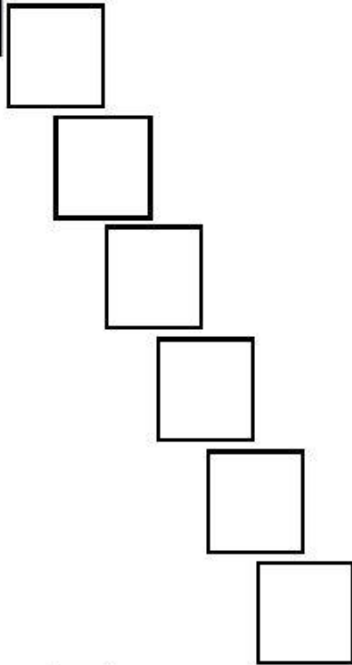
## PMT graphemes

These graphemes and icons may be cut out and laminated for manipulation in treatment.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| p | b | f | v | t | d | k | g | th | <u>th</u> |
| s | z | sh | zh | ch | j | l | r | m | n |
| ng | h | w | wh | ee | i | e | ae | a | u |
| o | aw | au | oe | uu | oo | er | ir | ur | or |
| ar | ie | ue | oi | oy | ou | ow | | | |

## Non-words to use in treatment

| 1 syllable | 2 syllables |
|---|---|
| doi | chootee |
| af | foekoe |
| toos | leber |
| sheev | doeum |
| ek | mefoe |
| dach | shever |
| peenz | fee<u>the</u>r |
| poeuh | toiler |
| meeth | iezl |
| ish | shaybee |
| whup | veeder |
| breek | zower |
| voo | tawthee |
| eep | jiver |
| reesh | wooter |
| nie | dungee |
| iej | turmee |
| zien | lekee |
| broiz | juroe |
| thag | shasoe |
| oit | hoyter |
| kur | neenee |
| froos | raezl |
| graek | hieger |
| choy | woewuh |
| oos | unger |
| faps | miever |
| woy | jawvee |
| awch | prezhur |
| plown | fooer |
| zae | pire[8] |
| hob | driepur |
| veed | gower |
| | teever |
| | iebee |

This is the proscribed list of low phonotactic probability and high neighborhood density non-words that are recommended for repeated use throughout treatment, and should be used daily across tasks at all levels once syllables have been introduced. Early in the program, when they are first being introduced, you might use them for just a few minutes in the session, during a single task (e.g., repetition). As treatment progresses, these stimuli are incorporated progressively across more tasks (e.g., stimulus chaining, reading aloud) and for more time during each session; by the end of the treatment program,

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[8] This rhymes with 'fire'. It is not written in PMT orthography format because it would be mistaken for the real word 'pier'.

these items become the primary stimuli being used in treatment. Note that tasks that involve these non-words will also include other non-words that are not on the list; for example, in a syllable chaining task you may start with a non-word from this list and move through a chaining sequence at arrive at another non-word from this list (e.g., *voo → voy → vee → veed*). We recognized that a few of these items are real words, but they are obscure enough that most clients do not recognize them as such. Therefore, we have chosen to include them in the interest of having enough items available that meet the lexical criteria for phonotactic probability and neighborhood density.

## Real word stimuli to be used in treatment

| Real word | PMT orthography |
|-----------|-----------------|
| plane | plaen |
| bride | bried |
| bruise | brooz |
| gravy | graevee |
| clover | kloevir |
| speaker | speekir |
| pie | pye |
| fur | fer |
| knee | nee |
| maze | maez |
| ditch | dich |
| wheel | weel |
| mop | mawp |
| fire | fier OR fieur |
| knob | nawb |
| cave | kaev |
| bird | berd |
| jail | jael |
| witch | wich |
| knot | nawt |
| meadow | medoe |
| ivy | ievee |
| jeans | jeenz |
| level | levul OR levl |
| shoulder | shoeldir |
| ranger | raenjer |
| heater | heetir |
| teacher | teechir |
| movie | moovee |
| polo | poeloe |
| genie | jeenee |
| halo | haeloe |
| father | faw<u>th</u>ir |
| jockey | jaukee OR jawkee OR jokee |
| tiger | tiegir |
| diver | dievir |
| shower | shouwir OR showir |
| ape | aep |
| owl | oul |

This is the proscribed list of low phonotactic probability and high neighborhood density real words that are recommended for repeated use throughout treatment, and should be used regularly across tasks at

all levels once syllables have been introduced. These words should be interwoven into tasks that are based in non-words; for example, in a syllable chaining task you may start with a non-word and move through one or more real words through the course of the task (e.g., *voo → vae → vaech → aech → aep → aef → laef*). Remember that real words used in PMT are treated the same as non-words, with a focus only on the phonological aspects of the word and not the semantic aspects. If they are written down or represented with grapheme tiles, they should be written using PMT orthography rather than conventional English orthography.

# Examples of Word/Syllable Chains

*When making your own chains, consider whether 'wider' (easier) or 'closer' (harder) contrasts between items are indicated. Think about the phoneme categories as well as voicing to determine contrast. Please refer to the manual section* Adjusting task difficulty and facilitating client success *for more methods to increase/decrease task difficulty when making chains.*

| New word each trial: | Change 1-phoneme each trial (different position): |
|---|---|
| toos | toos |
| sheev | toob |
| meeth | moob |
| reesh | meeb |
| hob | sheeb |
| fop | shoeb |
| veed | shoeg |
| dach | loeg |
| neep | lieg |
| zien | dieg |

| Change 1-phoneme each trial (same position): | Syllable chain: |
|---|---|
| toof | vee |
| toob | veeder |
| toosh | kunveeder |
| toov | kunveeshun |
| toop | kunmooshun |
| toog | mismooshun |
| tooch | mismoofer |
| tooz | mismooten |
| toos | mooten |
| tood | moo |

## Examples of phonotactically legal consonant clusters in English

Note that the examples are written in standard English orthography

| Onset clusters | | Final clusters | | | |
|---|---|---|---|---|---|
| Cluster | Example | Cluster | Example | Cluster | Example |
| Bl- | Black | -dj | Edge | -pt | Inept |
| Br- | Brown | -dz | Meds | -rb* | Carb |
| Dr- | Dream | -ft | Rift | -rch | Perch |
| Dw- | Dwarf | -ks | Locks | -rd | Hard |
| Fl- | Flow | -kt | Fact | -rf | Wharf |
| Fr- | Fry | -lb | Bulb | -rj | Urge |
| Gl- | Glide | -lch | Mulch | -rk | Park |
| Gr- | Grape | -ld | Old | -rl | Girl |
| Kl- | Clay | -lf | Elf | -rm | Farm |
| Kr- | Crush | -lk | Milk | -rn | Burn |
| Kw- | Quiet | -lm | Elm | -rp | Tarp |
| Pl- | Place | -lp | Gulp | -rs | Purse |
| Pr- | Prawn | -lt | Built | -rsh | Harsh |
| Sk- | Skip | -lv | Solve | -rt | Cart |
| Skr- | Scratch | -mp | Lamp | -rth | Hearth |
| Skw- | Squid | -mz | Homes | -rv | Swerve |
| Sl- | Sleep | -nch | Finch | -sk | Risk |
| Sm- | Smile | -nd | Round | -sp | Wasp |
| Sn- | Snap | -nj | Change | -st | Best |
| Sp- | Spin | -nk | Think | -thm | Rhythm |
| Spl- | Splash | -nt | Mint | -ts | Bets |
| Spr- | Spring | -nz | Bins | -vz | Lives |
| St- | Stem | -ps | Lips | -zm | Chasm |
| Str- | Strap | | | | |
| Sw- | Swipe | | | | |
| Shr- | Shrug | | | | |
| Tr- | Truth | | | | |
| Tw- | Twin | | | | |
| Thr- | Three | | | | |
| Thw- | Thwart | | | | |

*In some dialects, r-based clusters may not qualify as consonant clusters. The clinician should use or not use these clusters as appropriate.

This list is based on principles of phonotactic legality outlined in Algeo (1978).

## Examples of real words with conventional spelling in PMT orthography

This list can be helpful during orthographically-based tasks for clients with more severe aphasia. These can be used as a quick reference if desired, but you may choose other words, as well. Note: These are not the proscribed real words for use with all clients. These may be helpful if a client is having difficulty with a non-word (this often occurs particularly with complex consonant clusters); you can put the non-word into a real word context to facilitate its production, and then remove individual phonemes to gradually move back to the non-word. Note that these words are written in standard English orthography.

| CV (including rhotic vowels | VC | CVC | | CCVC | CVCC |
|---|---|---|---|---|---|
| bar | am | big | mob | bleed | best |
| bee | at | but | mom | broom | best |
| doe | if | dad | mud | brim | fast |
| far | in | did | mug | drip | hand |
| fee | it | dig | not | drop | help |
| fur | on | fan | nod | drum | hint |
| goo | up | fat | pot | flag | hunt |
| her | us | fib | peek | flat | husk |
| jar | | fit | pun | flip | jump |
| nor | | gas | rag | flop | just |
| paw | | get | ram | frog | keeps |
| raw | | got | rat | glad | kept |
| saw | | had | rod | grab | lift |
| sir | | hot | rot | plan | mist |
| toe | | jet | rug | skid | must |
| too | | kit | sad | slam | pond |
| lee | | lit | sat | sled | romp |
| now | | lid | sit | sleep | runt |
| see | | mad | sum | slim | seeps |
| tie | | man | ten | slip | shift |
| vow | | mat | tip | slot | taps |
| woe | | | | smog | test |
| | | | | snap | went |
| | | | | snip | |
| | | | | snug | |
| | | | | stop | |
| | | | | swam | |
| | | | | sweep | |
| | | | | swim | |
| | | | | swoop | |
| | | | | trim | |
| | | | | tweed | |
| | | | | twig | |

## Phonemes with no features shared (differ on 3 features) – Easiest to differentiate

| BASE | No shared features |
|------|--------------------|
| b | s, sh, f, th, ch, h |
| p | z, zh, v, <u>th</u>, j, n, w, r, l |
| d | sh, f, th, h |
| t | <u>th</u>, v, zh, m, w, r |
| g | h, ch, th, sh,s, f |
| k | j, <u>th</u>, v, zh, r, l |
| th | b, d, g, j, m, w, r, l |
| <u>th</u> | p, t, k, ch |
| f | b, d, g, m, w, n, r, l |
| v | p, t, k, ch |
| s | b, g, m, r, w |
| z | p, t, k, h |
| m | t, k, f, th, s, sh, h |
| n | p, k, f, th, sh, h, ch |
| w | f, th, t, s, ch, k, h |
| l | p, k, f, th, ch, h |
| r | p, k, f, th, h |
| h | b, d, g, m, w, l, r, n, j |
| ch | b, d, g, <u>th</u>, z, v, m, n, w, r, l |
| sh | b, d, g, j, l, m, n, w, r |
| zh | p, t, k, h |
| j | p, t, k, f, th, h |

## Phonemes with 1 feature shared (differ on 2 features) – Moderate difficulty to differentiate

| BASE | 1 shared feature |
|------|------------------|
| b | t, k, v, <u>th</u>, z, zh, l, n, r, j |
| p | d, g, f, th, s, sh, h, ch |
| d | p, k, m, w, v, <u>th</u>, j, zh, s |
| t | b, g, ch, f, th, sh, h, s |
| g | p, t, j, <u>th</u>, zh, z, v, l, n, m, w, r |
| k | b, d, ch, sh, s, th, f |
| th | v, z, zh, p, t, k, ch |
| <u>th</u> | v, z, zh, b, d, g, m, w, l, n, r, j |
| f | z, zh, <u>th</u>, p, t, k, ch |
| v | th, s, sh, h, b, d, g, j, m, w, n, r, l |
| s | v, <u>th</u>, z, zh, p, k, ch, d, l, n, r |
| z | f, th, s, sh, h, b, d, g, m, w, d, l, n, r |
| m | v, z, <u>th</u>, zh, l, r, d, g, j, p |
| n | v, <u>th</u>, zh, b, g, j, s, t |
| w | v, <u>th</u>, z, zh, n, l, d, g, j, p |
| l | b, g, <u>th</u>, j, v, zh, m, w, s, t |
| r | b, m, w, v, <u>th</u>, zh, j, g, s, t |
| h | v, z, zh, p, t, k, ch |
| ch | p, t, k, f, th, s, h, zh |
| sh | v, z, p, t, k, j |
| zh | v, z, b, d, g, j, l, m, n, w, r, ch |
| j | b, d, g, v, th, z, zh, l, m, n, w, r, sh |

Phonemes that share 2 features (differ on 1 feature) – Most difficult to differentiate

| BASE | 2 shared features |
|------|-------------------|
| b | d, g, m, w, p |
| p | t, k, b |
| d | b, g, z, l, n, r, t |
| t | p, k, s, d |
| g | b, d, k |
| k | p, t, g |
| th | f, s, sh, h, <u>th</u> |
| <u>th</u> | v, z, zh, th |
| f | th, s, sh, h, v |
| v | <u>th</u>, z, zh, f |
| s | f, th, sh, h, z |
| z | v, zh, s |
| m | n, b, w |
| n | m, r, l, z, d |
| w | r, m, b |
| l | d, z, n, r |
| r | n, l, z, d |
| h | f, th, s, sh |
| ch | sh, j |
| sh | f, th, s, h, ch, zh |
| zh | v, j, sh |
| j | zh, ch |

# Client candidacy for PMT

Good candidates for PMT typically meet the following criteria:

- Have a phonological processing impairment as part of aphasia, as documented by the presence of phonologic errors in a variety of linguistic contexts and/or performance on tests of phonological processing;
- Can repeat at least some single sound stimuli with cues;
- Are willing and able to be actively engaged in the treatment;
- Have sufficient auditory comprehension skills to participate in Socratic questioning;
- Are able to self-reflect (i.e., identify errors and change behavior to fix them);
- Have adequate speech motor programming, planning, and execution skills to participate in verbal treatment tasks;
- Have good executive function, including abstraction and set shifting.

In our experience, people who exhibit the following characteristics do not respond well to PMT:

- They do not have good buy-in, usually because they do not understand or like the concept of a treatment using primarily nonwords;
- They are unwilling to actively engage in the treatment tasks;
- They cannot be facilitated to repeat single sounds accurately;
- They have untreated depression.

PMT has been developed specifically for, and tested with, people with aphasia due to a left hemisphere stroke. No data are available that support its use with other etiologies; it may or may not be appropriate to use with other diagnoses that may yield acquired language impairments, such as traumatic brain injury or primary progressive aphasia.

What supplies are needed to deliver PMT? for details about these items.

| **Required** | **Recommended** |
|---|---|
| Small mirror | Clipboard |
| Mouth photos | Second set of mouth pictures |
| Voiced/voiceless icons | Second set of grapheme tiles |
| Laminated blank vowel circle chart | "Reset" button |
| Grapheme tiles | Plastic bin for storage and transport |
| Wipe-off board, markers, and eraser | |
| Small colored blocks | |
| Colored felt squares | |
| Blank index cards | |

# Sample PMT Goals

These sample goals are meant to be used as a guide, to demonstrate how you might incorporate PMT tasks and skills into a typical goal format for documentation. Please note that these are examples only, and should be used only as models for building appropriate clinical goals specific to each client.

___

<u>Speaking</u>

Long term goal 1: Client will expressive increase phonological awareness to reduce the amount and/or duration of anomic episodes in order to improve conversational efficiency.

Long term goal 2: Client will increase expressive phonological awareness to verbalize wants and needs effectively with different conversational partners in different communicative contexts.

1. Short term goal 1: Client will accurately verbalize a phoneme when provided with a _____ stimulus in _____ out of _____ trials and with _____ support.
2. Short term goal 2: After repeating a phoneme (consonants and vowels), client will identify place, manner, and voice with ____% accuracy.
3. Short term goal 3: Given a written stimulus, client will accurately verbalize a real or non-word target, as well as identify its associated phonemes and syllables, in _____ out of _____ trials with _____ support.

<u>Listening</u>

Long term goal: Client will increase receptive phonological awareness to improve comprehension during everyday conversations.

1. Short term goal 1: Client will accurately identify mouth pictures (consonants and vowels) when provided with an auditory stimulus in _____ out of _____ trials and with _____ support.
2. Short term goal 2: Given an auditory word pair and using blocks/felts as visual support, client will identify the location of a phoneme change in a syllable chaining task with _____% accuracy.

<u>Reading</u>

Long term goal: Client will develop functional decoding skills to independently read and understand everyday reading material.

1. Short term goal 1: Client will accurately associate sound to letter (and letter to sound) correspondences on _____ out of _____ trials.
2. Short term goal 2: Client will identify letters in a field of _____ with ____% accuracy and _____ cues.

3. Short term goal 3: Client will accurately associate sound to letter correspondences in order to decode stimuli (real or non-word) strings in _____ out of _____ trials.

<u>Writing</u>

Long term goal: Client will develop functional spelling skills to independently compose everyday written material (e.g. filling out forms, sending texts or email, etc.).

1. Short term goal 1: Client will write letters (consonants and vowels) given verbally produced phonemes with _____% accuracy and _____ cues.
2. Short term goal 2: Client will accurately write real or nonword stimuli from dictation in _____% opportunities.

Sample Data Sheets

**Consonant Progress Chart**

| | Isolation | | Combination | | |
|---|---|---|---|---|---|
| | Introduced/In progress | Mastered (>80% indp) | Single syllable - simple | Single syllable - complex | Multiple syllables |
| p | | | | | |
| b | | | | | |
| f | | | | | |
| v | | | | | |
| t | | | | | |
| d | | | | | |
| k | | | | | |
| g | | | | | |
| th | | | | | |
| th | | | | | |
| s | | | | | |
| z | | | | | |
| sh | | | | | |
| zh | | | | | |
| ch | | | | | |
| j | | | | | |
| l | | | | | |
| r | | | | | |
| m | | | | | |
| n | | | | | |
| ng | | | | | |
| h | | | | | |
| w/wh | | | | | |

## Vowel Progress Chart

|  | Isolation | | Combination | |
|---|---|---|---|---|
|  | Introduced/In progress | Mastered (>80% indp) | Single syllable | Multiple syllables |
| ee |  |  |  |  |
| o/aw/au |  |  |  |  |
| oo |  |  |  |  |
|  |  |  |  |  |
| i |  |  |  |  |
| e |  |  |  |  |
| ae |  |  |  |  |
| a |  |  |  |  |
| u |  |  |  |  |
| oe |  |  |  |  |
| uu |  |  |  |  |
|  |  |  |  |  |
| er/ir/ur |  |  |  |  |
| or |  |  |  |  |
| ar |  |  |  |  |
|  |  |  |  |  |
| ie |  |  |  |  |
| ue |  |  |  |  |
| oi/oy |  |  |  |  |
| ow/ou |  |  |  |  |

## Sounds in ISOLATION Progress Chart

| | Supported | Independent | |
| --- | --- | --- | --- |
| | Introduced/In progress | Perception | Production |
| p | | | |
| b | | | |
| f | | | |
| v | | | |
| t | | | |
| d | | | |
| k | | | |
| g | | | |
| th | | | |
| th | | | |
| s | | | |
| z | | | |
| sh | | | |
| zh | | | |
| ch | | | |
| j | | | |
| l | | | |
| r | | | |
| m | | | |
| n | | | |
| ng | | | |
| h | | | |
| w/wh | | | |
| | | | |
| ee | | | |
| o/aw/au | | | |
| oo | | | |

## Sounds in ISOLATION Progress Chart

| | Supported | Independent | |
|---|---|---|---|
| | Introduced/In progress | Perception | Production |
| | | | |
| i | | | |
| e | | | |
| ae | | | |
| a | | | |
| u | | | |
| oe | | | |
| uu | | | |
| | | | |
| er/ir/ur | | | |
| or | | | |
| ar | | | |
| | | | |
| ie | | | |
| ue | | | |
| oi/oy | | | |
| ow/ou | | | |

## Sounds in COMBINATION Progress Chart

|  | Single syllables | | Multiple syllables | |
|---|---|---|---|---|
|  | Simple | Complex | Simple | Complex |
| p |  |  |  |  |
| b |  |  |  |  |
| f |  |  |  |  |
| v |  |  |  |  |
| t |  |  |  |  |
| d |  |  |  |  |
| k |  |  |  |  |
| g |  |  |  |  |
| th |  |  |  |  |
| th |  |  |  |  |
| s |  |  |  |  |
| z |  |  |  |  |
| sh |  |  |  |  |
| zh |  |  |  |  |
| ch |  |  |  |  |
| j |  |  |  |  |
| l |  |  |  |  |
| r |  |  |  |  |
| m |  |  |  |  |
| n |  |  |  |  |
| ng |  |  |  |  |
| h |  |  |  |  |
| w/wh |  |  |  |  |
|  |  |  |  |  |
| ee |  |  |  |  |
| o/aw/au |  |  |  |  |
| oo |  |  |  |  |

## Sounds in COMBINATION Progress Chart

| | Single syllables | | Multiple syllables | |
|---|---|---|---|---|
| | Simple | Complex | Simple | Complex |
| i | | | | |
| e | | | | |
| ae | | | | |
| a | | | | |
| u | | | | |
| oe | | | | |
| uu | | | | |
| | | | | |
| er/ir/ur | | | | |
| or | | | | |
| ar | | | | |
| | | | | |
| ie | | | | |
| ue | | | | |
| oi/oy | | | | |
| ow/ou | | | | |

## Data Sheet: Sounds in Combination

| Date | Input (circle) | Output (circle) | Level (e.g., CV, CVCV, # syllables), Position (e.g. initial/medial/final) and Cueing used | Accuracy (+/- or % correct) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

### Key

= speech

= mouth pictures

= mouth descriptions

= letter tiles

= writing

= colored blocks

= colored felts

# Glossary of Terms

**Agraphia** – Impaired ability to write.

**Alexia** – Impaired reading ability.

**Aphasia** – An acquired impairment of access to language representations and processes that crosses all language modalities (verbal expression, auditory comprehension, reading, and writing) and involves impairments in attention and working memory, as well.

**Blending** –Taking separate phonemes and merging them into a single syllable (e.g., given *b*, *e*, *f*, create the syllable *bef*).

**Blocked trials** – A series of trials of a task that all use the same stimulus or structure. For example, a chaining task may only change the final phoneme on each successive trial (e.g., *sath* → *saf* → *sab* → *saj*). Contrast with **random trials**.

**Cognate pairs** – Two phonemes that differ in only in the phonological feature of voicing (i.e., *p/b, f/v, t/d, k/g, th/<u>th</u>, s/z, sh/zh, ch/dz*)

**Compensatory treatments** – Therapy approaches that are designed to improve a person's ability to communicate functionally without an expectation that fundamental language processing skills will improve. Examples include training to use a communication notebook and using writing or drawing to supplement verbal communication. Compare with **restorative treatments**.

**Diphthong** – A vowel that has two articulatory components blended together, moving from one to the other (e.g., *ie* begins with the open-jaw posture of *o* and moves to the closed-jaw posture of *ee*) Contrast with **monophthong**.

**Elision** – Removing a single phoneme from a syllable or word (e.g., "Say *tesk* without saying *t* " or "Say *pimz* without the *z*").

**Executive functioning** – The collection of cognitive processes that regulate the ability to organize, plan, implement, and complete tasks. These generally include attention, working memory, self-monitoring, planning, initiation, and inhibition.

**Grapheme** – a written letter.

**Interactive activation model of language** – A model of language that assumes that the different types of representations in the lexical network (i.e., semantic, lexical, and phonological) are organized in a somewhat hierarchical manner, but that all elements at each level interact with the related elements at the levels above and below them.

**Language domains** – The various sensory and cognitive processing networks that support language function (e.g., visual, acoustic, tactile-kinesthetic, etc.).

**Language modalities** – The various ways to use language (e.g., verbal expression, auditory comprehension, reading, writing).

**Lexical network** – A network of words and related language elements that a person has stored in their memory.

**Monophthong** – A vowel that has only one articulatory component, so that the beginning and end of the vowel are relatively consistent with each other. Contrast with **diphthong**.

**Neighborhood density** – A measure of how many words in a language are similar to a given word, generally defined as words that can be made by adding, subtracting, or replacing one sound or letter in the word. Neighborhoods can be phonological (defined in terms of speech sounds) or orthographic (defined in terms of letters used in writing, even if the words don't sound similar). For instance, the word *cat* has high phonological neighborhood density, with many words that are phonologically similar by the "change one sound" definition, including 'mat', 'cast', 'cab', 'scat', 'cot', and many others. In contrast, the word *elephant* has low neighborhood density, with only a few neighbors: 'element' and 'elegant'.

**Non-words** – Strings of sounds that are legal in the language (i.e., could be a real word), but do not have any meaning. Examples: *frip, smick, bruthbem.*

**Orthography** – Letters used to write words.

**Parsing** – Taking a syllable (or syllables) and breaking it out into its constituent phonemes (e.g., given *pag*, identify the phonemes *p*, *a*, and *g*).

**Phonemes** – Speech sounds that are used to create words. Phonemes are generally defined by their **phonological features**.

**Phoneme sequence knowledge** – A person's knowledge of the ways in which sounds in a language can be used together. This knowledge may not be explicit (i.e., conscious), but is critical to a person's ability to assemble words to produce them in speech.

**Phonological awareness** – A person's ability to recognize, identify, discriminate between, and manipulate individual speech sounds outside of the context of real words.

**Phonological features** – Parameters that are used to distinctively define speech sounds. Each sound in a language can be defined by its: 1) Place of articulation (i.e., what structures are active in producing the sound); 2) Manner of articulation (i.e., how those structures move in producing the sound); and 3) Voicing (i.e., whether the voice is turned on or off when the sound is being produced).

**Phonology** – A system of speech sounds and sound combinations that are permissible in a language.

**Phonotactic probability** – A measure of how common a sound combination is in the language. "High phonotactic probability" means that the sound or sound combination is common in the language (e.g., *st*). "Low phonotactic probability" means that the sound or sound combination is uncommon in the language (though still permissible; e.g., *zh*, as in 'measure', or the non-word syllable *zow*).

**Random trials** – A series of trials of a task that randomly change which element is manipulated from trial to trial. For example, a chaining task may change the phoneme in a different position on each successive trial (e.g., *sath → saff → suff → luff*). Contrast with **blocked trials**.

**Restorative treatments** – Therapy approaches that are designed to improve basic communication functions and abilities, such as word retrieval, reading skills, and auditory comprehension. Examples include Phonomotor Treatment, Semantic Feature Analysis, and Treatment of Underlying Forms. Compare with **compensatory treatments**.

**Rhotic vowels** – Vowels produced in the context of *r*.

**Socratic questioning** – A process of asking questions to lead the listener on a path of self-discovery.

**Speech motor programming/planning** – The cognitive and motor processes that translate a linguistic plan into an executable set of motor commands.

**Spondee** – A word with two syllables that are relatively equally stressed.

**Tactile-kinesthetic** – Involving information about how it feels to make a particular speech sound and how the structures involved move.

**Verbal working memory** – The combination of verbal short-term memory (which is temporary and has limited capacity) with attention that allows manipulation of linguistic information.

# Answers and Explanations for Quiz Modules

## Quiz Module #1 – Theoretical motivations for PMT

1. Phonomotor treatment is based on the idea that lexical processing occurs…
   **in networks that are massively interconnected, with representation resulting from the co-activation of elements across domains.**

   EXPLANATION FOR Q1: PMT is based on a parallel distributed processing model of language, which describes language as the product of a massively interconnected network.

2. PMT is rooted in the understanding that lexical processing is supported by…
   **the interaction of information across sensory-motor domains.**

   EXPLANATION FOR Q2: Consistent with a parallel distributed processing model of language, PMT assumes that processing of words involves integrating information across language and related modalities.

3. In PMT, various behavioral modalities are routinely…
   **paired between stronger and weaker modalities to facilitate improvement.**

   EXPLANATION FOR Q3: PMT is designed to use the interconnected nature of the distributed networks that support language to improve skills and domains that are impaired. One way this is done is by pairing weaker modalities with relatively preserved skills, to reinforce the weaker knowledge.

4. The goal of PMT is to…
   **Build phonological awareness and phonological sequence knowledge**.

   EXPLANATION FOR Q4: PMT is designed to improve phonological awareness and phonological sequence knowledge, rather than specific sounds or words. This focus on the fundamental elements that support all language processing allows the potential for treatment to have wide-ranging effects across language domains, structures, and lexical items, rather than just on the items that have been trained.

## Quiz Module #2 – The structure of the PMT program

1. PMT begins with introducing single phonemes and then moves to working with phoneme combinations.

   **True**

   EXPLANATION FOR Q1: The overall structure of the PMT program involves beginning with training single phonemes. Once each individual phoneme has been trained in isolation, though, it is moved into short combinations even if there are other phonemes not yet introduced. This is discussed in greater detail in the section on Progression through the task hierarchy.

2. Treatment focuses on production of specific sounds, and a sound is considered "mastered" when the client produces it 100% accurately.

   **False**

   EXPLANATION FOR Q2: The focus of PMT is not on production of specific sounds; rather, it is on awareness of sounds and how they are produced and used in language. A single phoneme is considered "trained" when it has been explored across tasks that require identification, discrimination, and description of the phoneme in isolation. Once the phoneme has been trained in isolation it can be moved into combinations with vowels, even if production accuracy is not yet very high.

3. PMT uses only non-words in treatment.

   **False**

   EXPLANATION FOR Q2: While most of PMT uses non-words, there are some carefully selected real words that should be used later in the treatment program to help encourage linking phonological information with semantic information. Even when real words are used, though, the focus of treatment is always on the phonological aspects of the word; semantics are never directly addressed.

4. Training of syllables only happens after all training of single phonemes is complete.

   **False**

   EXPLANATION FOR Q3: It is not necessary to have all phonemes introduced before beginning to work with syllables. As a client becomes familiar with each individual phoneme, it can be moved into syllable contexts, even if there are other phonemes still being introduced. The one limitation on task progression is that all individual phonemes should be introduced before moving any into multi-syllable combinations.

## Quiz Module #3 – Socratic Questioning

1. Socratic questioning involves…

   **Using carefully crafted questions to guide the client through exploration of phonemes, stimuli, and their own responses to treatment tasks.**

   EXPLANATION FOR Q1: One critical element of PMT is having the client think deeply about phonology across modalities. This is achieved by using Socratic questioning to guide them through a process of self-discovery, for both correct and incorrect responses, rather than just giving them feedback about response accuracy and explaining things to them.

2. Socratic questioning for a single trial usually involves just a single question.

   **False**

   EXPLANATION FOR Q2: The Socratic questioning process generally involves a series of questions to evaluate a stimulus or response. It is an interactive, iterative process, which may take several minutes for a single treatment trial.

3. The clinician should always use the same questions for the same tasks during PMT.

   **False**

   EXPLANATION FOR Q3: Socratic questioning will change over the course of treatment, based on the client's current performance, the desired focus of the task (which may change from one session - or trial - to another), and the relative balance of domain strengths over the course of recovery. Keep in mind that Socratic questioning isn't about teaching clients specific information about phonemes, but is about guiding the client through a process of evaluation, self-reflection, and assessment with the goal of increasing their awareness, knowledge, and ability to self-monitor and self-cue.

4. Socratic questioning evolves over the course of treatment, depending on the client's strengths, challenges, and current level of success.

   **True**

   EXPLANATION FOR Q4: See response to Q3.

5. Socratic questioning should facilitate linking relatively stronger with relatively weaker modalities.

   **True**

   EXPLANATION FOR Q5: One of the strengths of PMT is its pairing of stronger modalities with those that are weaker; this pairing allows the weaker modality to become stronger. One way modalities are paired is through the process of Socratic questioning, in which the clinician has the client explore related aspects of the stimulus or response across modalities. For instance, if

visual and acoustic analysis skills are relatively strong but awareness of oral movements is poor, Socratic questioning may first focus on what a sound production looks and sounds like when the clinician says it, and then shift to having the client look in a mirror while s/he produces it, describing the sound of their own production, and then describing the articulatory mouth movements involved in producing that sound.

6. A client with impaired auditory comprehension is not a good candidate for PMT, because auditory comprehension needs to be fully intact to participate in Socratic questioning.
    **False**

    EXPLANATION FOR Q6: It is important for clients to be able to participate in Socratic questioning in PMT, but this is still possible even if their auditory comprehension is impaired. Auditory information can be modified or supplemented to support the ability to participate in Socratic questioning, even if auditory comprehension is impaired.

7. The best way to support a client's ability to engage in the Socratic questioning process is to…
    **All of the above.**

    EXPLANATION OF Q7: The clinician should use whatever methods are effective, in any combination, to facilitate a client's ability to participate in Socratic questioning.

## Quiz Module #4 – Conceptual introduction to PMT

1.  PMT is intuitive enough that you can jump into treatment without any preliminary explanation.
    **False**

EXPLANATION OF Q1: The approach taken by PMT is unusual, and likely very different from what people with aphasia have experienced previously in their therapy. While most aphasia treatments have a fairly obvious tie to functional communication, through working on specific client-driven vocabulary or functional tasks, PMT's focus on phonology in non-word contexts can be difficult to understand. Poor understanding can lead to poor buy-in and commitment to treatment. For these reasons, we have found it to be critical to provide a thorough explanation of the motivation for doing PMT, as described in this manual, before beginning treatment, and returning to it as needed throughout the therapy program.

2.  The explanation and drawing that represent the purpose of PMT should be provided at the start of each treatment session.
    **False**

EXPLANATION OF Q2: The detailed explanation of the motivation for using PMT does not need to be presented prior to each session. In our experience, clients do well having it presented before the first session, and then it can be referenced briefly if needed as questions or lapses in motivation occur during treatment.

3.  The explanatory drawing that represents the purpose of PMT should be created anew for each client as you describe the purpose of the treatment, rather than having it pre-drawn.
    **True**

EXPLANATION FOR Q3: The explanation for how and why PMT works is complex, and explaining it to someone with aphasia adds an extra level of difficulty that the clinician must anticipate. One way to manage this, and maximize, client understanding, is to build the explanatory drawing(s) gradually, adding each element as you talk about it. This helps to break down the ideas into manageable pieces, and in the process serves as multi-modality communication support for clients with impaired auditory comprehension.

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