

Appendix A: Phonomotor treatment protocol

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Treatment materials	<ul style="list-style-type: none"> • Small mirror • Line drawings of mouth postures, icons for voiced/voiceless consonants • Letter tiles • Wipe-off board with markers • Small colored blocks 	
	Stage 1: Sounds in Isolation	Stage 2: Sounds in syllables
Overview	<p>The purpose of Stage 1 is to train sounds in <i>isolation</i> through multi-modal instruction using tasks designed to engage distributed articulatory-motor, acoustic, tactile-kinesthetic, and orthographic representations.</p> <p>Consonant sounds are introduced using mouth pictures and SLP model as cognate pairs by place/manner of articulation and grouped according to tactile-kinesthetic description (lip, tongue, air, nasal, wind). They are introduced in the following order: lip (<i>p/b, f/v</i>), tongue (<i>t/d, k/g, th/th</i>), air (<i>s/z, sh/zh, ch/j</i>), tongue (<i>l/r</i>), nasal (<i>m/n/ng</i>) and wind (<i>h/w/wh</i>). When mastery of a consonant pair is achieved (e.g. <i>p/b</i>) in perception and production (approximately 85% accuracy), the next sound pair is introduced (e.g. <i>t/d</i>). Once a sound pair is introduced, training continues on this pair in all subsequent sessions. Once a participant can perceive and produce all consonants in isolation, corresponding graphemes are introduced using the corresponding mouth picture.</p> <p>Vowel sounds are trained according to lip and jaw placement via mouth pictures and letter tiles. Vowel sounds (<i>ee, o, oo</i>) are introduced with consonants to allow for minimal pair discrimination (e.g., <i>eep, op, oop</i>). The remaining vowels are trained after consonants.</p>	<p>The purpose of Stage 2 is to extend skills acquired in Stage 1 to <i>phoneme sequences</i>. Treatment tasks remain similar to Stage 1 tasks, with the exception that sounds will be produced in combinations rather than isolation. Training progresses from shorter, monosyllabic sequences to longer, multisyllabic (more complex) sequences (e.g., VC, CV, CVC, CCV, VCC, CCVC, CVCC, CCVCC, CVCV). Both real and nonwords are trained using phonologic tasks (in other words, only phonological features, <i>not</i> semantic features, are trained for real words). Nonword training is introduced before real word training to allow for emphasis on phonology; however, as treatment progresses nonwords and real words are trained simultaneously.</p>
<i>Introduction of sounds and sound sequences</i>	<p>Participant observes SLP producing a single sound (e.g. <i>/p/</i>). SLP asks participant what they observed (heard, saw) and if needed, describes what articulators are moving and how they move. For the sound <i>/p/</i>, for example, "the lips come together and blow apart, the sound is 'quiet' so the voice is turned off, the tongue is not moving." The participant is then shown the line drawing of the mouth posture corresponding to the sound.</p> <p>After looking at the mouth picture and hearing the SLP's production, the participant is then asked to repeat the sound while looking in the mirror. The participant is also asked to place their hand on their throat in order to feel for vocal fold vibration ("quiet" versus "noisy"). Following production, the SLP asks the participant what s/he saw and felt when the sound was made. Socratic questioning is used to enable the participant to "discover" the auditory, visual, articulatory, and tactile/kinesthetic attributes of the sound (e.g., "What do you feel when you make that sound? What moved? What did you see when you made that sound?" etc.). Within therapy progression for all levels is based on 85% accurate performance on task.</p>	<p>The process of "discovering" sounds primarily occurs in Stage 1; however, knowledge of the auditory, visual, articulatory and tactile/kinesthetic attributes of sounds can also be used later in the program as a cueing technique to identify individual phonemes within a phoneme sequence. For example, if a participant had trouble parsing the initial sound in <i>peef</i>, the SLP would use Socratic questioning (e.g., "What do you feel when you make that first sound? What moved? Did your lips or tongue move when you made that sound?" etc.) to help identify the initial sound <i>/p/</i>. Put differently, rather than give the participant a model and tell them what the initial sound is, the SLP assists the participant in self-awareness of errors and how to repair them.</p>

<p><i>Perception tasks</i></p>	<p>Perception of sounds in isolation can be trained through various multi-modal tasks. Examples:</p> <ul style="list-style-type: none"> • Mouth pictures: SLP produces a sound (e.g., <i>p</i>) and asks the participant to choose that sound from an array of mouth pictures (e.g., <i>p, b, t, d</i>) • Colored blocks: SLP produces a string of individual sounds (e.g., <i>p, t, t, b</i>) and asks the participant to lay out blocks to demonstrate ability to discriminate sounds (e.g., blocks: red, blue, blue, green). • Verbal: SLP produces two sounds (e.g., <i>p, p</i> or <i>p, b</i>) and asks the participant “same or different.” • Letters: SLP produces a sound and asks participant to point to the corresponding letter from an array of letters. 	<p>The SLP produces a real or nonword sound combination and asks the participant to depict the target through various tasks:</p> <ul style="list-style-type: none"> • Mouth pictures: If the participant heard the CVC <i>peef</i>, they would select the pictures corresponding to <i>p, ee</i>, and <i>f</i>. • Colored blocks: If the participant heard the CVCV <i>peefee</i>, they would select three differently colored blocks arranged in the following order: white, black, red, black. • Verbal: If the participant heard the CCVCs <i>groom</i> and <i>groom</i>, the SLP would ask “same or different.” • Letters: If the participant heard <i>chootee</i>, s/he would select the corresponding letter tiles.
<p><i>Production tasks</i></p>	<p>Production of sounds in isolation can be trained through various tasks. Here are some examples:</p> <ul style="list-style-type: none"> • Mouth pictures: The SLP shows participant a mouth picture and asks the participant to produce that sound (e.g., <i>d</i>). • Motor description: The SLP describes a sound (e.g., “make the sound where your voice is noisy and your tongue quickly taps the roof of your mouth”) and asks the participant to say the sound. • Verbal: The SLP asks the participant to repeat a sound <i>p</i> or a string of individual sounds <i>p, p, s, d</i>. • Letters: The SLP shows the participant a letter to elicit production of the sound. 	<p>The SLP elicits a real or nonword sound combination by asking the participant to produce the target through various tasks:</p> <ul style="list-style-type: none"> • Mouth pictures: The SLP lays out a series of mouth pictures and asks the participant to “touch and say” each sound (<i>f-ee-p</i>) and then blend the sounds to produce the target (<i>feep</i>). • Verbal: The SLP asks the participant to repeat a nonword <i>groom</i> and parse the word apart (<i>g-r-oo-k</i>). • Letters: The SLP lays out letter tiles (or writes letters on dry erase board). The participant parses out the sounds by underlining and verbalizing each grapheme and then blends the sounds to produce the target.

Note: This appendix is meant to provide an overview and quick reference for those already familiar with the phonomotor treatment program. Readers interested in implementing this program are strongly encouraged to contact the first author of this paper for further information.