ABSTRACT
PROMPT (Prompts for Restructuring Oral Muscular Phonetic Targets), a tactually grounded, deeply rooted, cognitive-linguistic intervention model, is explored as a new approach system and technique in the treatment of children with speech production disorders. PROMPT may be used for children or adults 2 years and older who have sensory, motor, and physiological impairments. The PROMPT conceptual framework and the Motor Speech Hierarchy are described. Intervention frameworks that help clinicians develop a holistic communication approach that centers on motor speech control for speech and language development. The function of tactile systems and use of tactile input are explained with relevance to the importance in early childhood motor and speech development. The neurological support they provide in developing speech production and why clinicians need to consider using focused tactile input in intervention.

INTRODUCTION
This chapter briefly explains the PROMPT model and its philosophical grounding on the interactive and dynamic nature of communication from which all domains must be considered in intervention (Hayden, 2004, 2006). PROMPT assumes that audition and somatosensory information (including tactile-kinesthetic-proprioceptive input) are equally important in the development and organization of motor speech behavior. These two distinguishing characteristics identify PROMPT as a dynamic and tactually grounded approach.

TARGET POPULATIONS AND ASSESSMENTS
FOR DETERMINING INTERVENTION RELEVANCE

Primary Populations
Children who benefit from PROMPT are
1. Children who have typical cognitive and social skills but evidence mild-to-severe oro-motor delays/disorders and motor speech difficulties. These include children with persistent articulation and/or phonological errors (Chumpelik [Hayden] & Sherman, 1984; Houghton, 2003).
2. Children with mild-to-severe sensory-motor impairments that affect their speech. These include children with hearing impairment (with or without cochlear implants) and children diagnosed with childhood apraxia of speech (CAS). PROMPT has also been reported to be effective for supporting initiation, transition, and timing of speech movements in motor planning for children with fluency disorders (Chumpelik [Hayden] & Sherman, 1984; Square, Goshulak, Bose, & Hayden, 2000).

3. Children with speech impairment who are diagnosed with disorders affecting the physical, sensory-motor, and cognitive domains. This group includes children with cerebral palsy (CP), Down syndrome, attention deficit disorder (ADD)/attention-deficit/hyperactivity disorder (ADHD), and developmental dysarthria, as well as pervasive developmental disorders (PDD) or autism spectrum disorder (ASD; Rogers et al., 2006; Sherman & Chumpelik [Hayden], 1981).

In summary, children for whom PROMPT is appropriate must have an articulation, motor speech or speech production disorder affecting execution, planning, fluency, or prosody. As well, the child must be able to attend to or be taught to attend to a single task for at least a few moments, engage in joint attention with another, and demonstrate verbal or nonverbal intent to communicate. Therefore it is generally recommended for use with children from 2 years or older, but may be used with children as young as 18 months.

**PROMPT Assessment Considerations**

In the PROMPT approach, a holistic assessment of the entire child is recommended across all developmental domains (Physical-Sensory, Cognitive-Linguistic, and Social-Emotional) to determine relative strengths and weaknesses and identify the best context for speech intervention. A communication focus allows the clinician to embed all goals and motor objectives within a larger functional communication framework.

In general, dynamic assessment techniques, as well as criterion-referenced or standardized test instruments may be used to determine the child's overall cognitive-linguistic and social-emotional functioning. Two recommended measures are The Vineland Social-Emotional Early Childhood Scales (Sparrow, Balla, & Cicchetti, 1998), which is used to obtain basic information about the child's cognitive and social skills, and a parent questionnaire (Carswell et al., 2000). The parent questionnaire helps determine how the parent believes the child is progressing in areas important to the child's societal functioning. Next, a formal articulation or phonological test, such as the Diagnostic Evaluation of Articulation and Phonology (DEAP; Dodd, Hua, Crosbie, Holm, & Ozanne, 2007), is used to determine what type of errors are present in the child's speech.

A PROMPT assessment must also include the System Analysis Observation (SAO) checklist (Hayden, 2006). The SAO is an observational checklist that assesses seven aspects of speech subsystem control and development (i.e., tone; breath support and valving; mandibular, labial-facial, lingual, sequenced actions; and prosody). The SAO includes both a structural observation at rest and a dynamic movement, or in spontaneous speech production, assessment of how the various speech subsystems have developed and are interacting.

The motor speech hierarchy (MSH; Hayden, 2004), shown in Figure 19.1, uses information from the SAO and was created to describe the interactive nature and development of the motor speech subsystems. It has been validated using objective measures (Square, Hayden, Ciolfi, & Wilkins, 1999), kinematic data (Green, Moore, Higashikawa, & Steeve,
Impairments that affect their speech, unit (with or without cochlear implants) of speech (CAS). PROMPT has undergone transition, and timing and speech with dysarthria, as well as praxis (Chumpe, 2000).

Diagnosed with disorders affecting language, motor control, or attention, and appropriate tasks, This group includes children with attention deficit disorder (ADD/ADHD), as well as other spectrum disorder (ASD; Rogen.

It is generally recommended for children as young as 18 months.

The entire child is recommended as a comprehensive framework. We develop a criterion-referenced or standard-based measure of the child's overall cognitive-linguistic, social-emotional, and fine-motor skills, and a parent questionnaire helps determine how the parent or the child's sociocultural functioning, such as the Diagnostic Evaluation of Speech, Holm, & Ozanne, 2007), is used to assess the child's speech.

System Analysis Observation (SAO) checklist that assesses seven skills (i.e., tone; breath support and valving, and prosody). The SAO includes both parental report and in spontaneous speech production, or in developmental, interactive nature and developmentally appropriate motor action sets or syllables can be identified and priorities within the speech subsystems delineated for intervention. The PROMPT lexicon is also developed through this process. Similar to the SAO, the MSH is divided into the seven stages named previously. These stages are also referred to as motor speech subsystems, parameters, and/or priorities (See Hayden, 2004, for a detailed description.)
To assess a child's motor system and response to various types of input (i.e., auditory, visual, tactile), the Verbal Motor Production Assessment for Children (VMPAC, Hayden & Square, 1999), which is based on the MSH model, may be used. This assessment tool uniquely evaluates motor speech subsystem development in three main areas: 1) global motor control, 2) focal oro-motor control, and 3) verbal and nonverbal sequencing of motor movements.

THEORETICAL BASIS

This section presents theories considered critical to PROMPT and related to PROMPT intervention. All of these ideas are interrelated and suggest how PROMPT uses somatosensory input to work toward interactive verbal communication.

Dynamic Systems Theory

Dynamic Systems Theory (DST) considers motor development as a process of self-organization arising from interactions among multiple factors, such as skeletal structure, brain development, and environmental conditions. Harnessing and controlling the many degrees of freedom involved in these interactions is essential in the development of motor control for speech. For example, in order to develop linguistic independence for productions such as *snake*, the jaw must be able to reduce its range and grade its movement (Schoner & Kelso, 1988; Thelen, 2004; Thelen et al., 1993).

Fogel and Thelen (1987) also suggested that development may be understood as a temporal series of attractor states; that is, muscle biasing conditions or states in which one motor pattern or type of motor pattern is dominant. Such states create stability within a complex system. Development occurs through phase shifts in which there is a transition from one attractor state to another. Phase shifts arise as a result of multiple interactions between intrinsic and extrinsic factors, such as an individual's physical development, the level of experience with a skill, environmental conditions, or the nature of the task. From this theoretical position, speech development is determined by a dynamic system influenced by interactions among both internal and external factors. Following this view, PROMPT works by enabling the child to move from less efficient attractor states through phase shifts to more efficient attractor states in order to help produce the most efficient and flexible motor control for the development of speech.

Neuronal Group Selection Theory

Neuronal Group Selection Theory (NGST) provides both a theoretical foundation and neurobiological underpinning to DST and strongly suggests that somatosensory input is necessary, especially in the early stages of typical motor and motor speech development or when learning a new motor skill. NGST enhances DST by helping explain the nature of the central nervous system (CNS) and its role in motor speech development (Guenther, 2006; Sporns & Edelman, 1993). NGST posits that neuronal groups are the basic functional units of selection, which are arranged in maps representing the body surface or visual space, which are anatomically coupled via long-range connections throughout the cortex (Pearson, Finkel, & Edelman, 1987).

In NGST, brain circuitry is considered plastic, responsive to environmental changes, and is determined by the selection of somatosensory inputs (Kass, 2004). NGST suggests
that after several successful attempts at a task, modified pathways are formed, which reorganize previous sensory maps. Neural connections are strengthened when they are involved in the successful generation of movement, resulting in natural selective shaping. It is also hypothesized that this selection is used for discrimination and categorization of sensory inputs and integrates both sensory and motor behavior, thereby producing adaptive behavior (Mondiris, Plautz, & Klein, 2005). The neural connections that are formed are reciprocal and provide integration across multiple sensory and motor areas.

Reentry, or recursive reciprocal signaling, then appears to be necessary for integrating multiple sensory and motor pathways in the brain. The maps created via the sensory receptors influence the appropriate execution of motor movement and reciprocally, accurate, articulate, and functional motor movement influences somatosensory selection. Also recognized within NGST are the multiple degrees of freedom that a motor system exhibits. Degrees of freedom refers to the amount of movement necessary across spatial planes, but within a limited framework, to achieve motor equivalence or a target movement. In order to handle this redundancy of motor movement or multiple degrees of freedom, it is proposed that the motor system is organized into classes of movement actions. This phenomenon, although producing a class of similar but not identical trajectories that nevertheless lead to the same outcome or target, has been described as motor equivalence (Abbs & Cole, 1987; Hebb, 1949). In other words, each articulator works with multiple muscle groups and articulators to achieve a target. These actions are not produced in isolation and involve a number of interactions that may be more realistically thought of as classes of motor action sets.

A prime supposition of NGST is that there must be spontaneous generation of a number of different primary movement patterns during early development that are produced with sufficient variability. It is suggested that most synergies emerge after early sensory-motor practice subsequent to postnatal development and underlie well practiced actions, such as walking, or reaching. These changes are thought to reflect both structural (biomechanical) changes and neural development (Jackson, 1958; Kent, 2004). The second supposition is that these movements must be sensed by the organism and have differential effects on the environment. Finally, NGST implies that the preceding steps (using sensory inputs) will produce synaptic change in various global mappings, thereby leading to successive and adaptive change of the motor behavior. NGST suggests the idea that dynamic tactual input is important in changing motor speech action sets or patterns of movement for speech production. It suggests that providing appropriately tailored somatosensory feedback that leads to intelligibility for functional purposes will alter existing neural maps to form new maps. Thus, NGST provides a neural explanation for DST and suggests that both the organism and the environment, or external manipulating events, can contribute to the development of flexible motor behavior.

Central Nervous System Maturation and Structural Changes in Early Development

As early as 1953, Jackson proposed that CNS maturation proceeds in “ascending development in a particular order” (Jackson, 1958, p. 46). His theory of CNS maturation acknowledged that early reflexes, developed in utero and after birth, provide a stable and basic repertoire of movement patterns that enable the infant to survive and interact with the environment. He suggested that in the typical infant, these reflexes are somewhat flexible. As maturation occurs, the development of higher cortical centers provides an inhibitory influence allowing movement patterns to gain even more flexibility and come
under conscious control. He indicated that CNS activity evolved from the most simple, most automatic, and most organized toward the most complex, least organized, and least automatic. Kent (Kent, 2004; Kent & Vorperian, 2007), realizing the interactive nature of speech development, described the biological basis for speech and suggested that the infant goes through successive remodeling and maturation of both structural and CNS systems. While Jackson looked at the innate changes brought about by CNS maturation, Kent called attention to the interaction of the physical, sensory-motor, and cognitive changes to the development of speech and language.

Jackson’s theory of evolution and dissolution reminds the clinician using PROMPT that early reflexes provide the initial or primary movement patterns with which the infant contacts his or her world and begins the diversification of multiple action sets. It is therefore critical that the clinician using PROMPT evaluate the client’s developmental stage and assess how much independence of movement may be achieved, ranging from reflex actions to consciously controlled motor behaviors. Kent’s work further reminds us that the development of the organism has a distinct relationship to the development of sound production. If normal development within the musculoskeletal system does not occur within the expected time periods, it may impede, to greater or lesser degrees, the ability of the motor speech system to develop adequate motor abilities for speech and, therefore, language.

Motor Learning Theories

Schema theory was originally discussed by Head (1926a, 1926b) as early as 1920. He proposed that creating a motor memory or “schema” involved the process of extracting core elements from motor experiences and that these elements reflect rules that have led to success in performing a given action. Bellezza (1987) proposed that these same features characterized successful speech schemas and that the rules underlying successful speech schemas encompassed core properties of one’s experience that could be tested continually and redefined by other experiences of a similar nature. Similar to NGST, schemas, as Bellezza proposed them, become more effective with greater repetition and through a wider variety of experiences with a similar activity. In this way the schemas become more dynamic and usable. In other words, patterns that require less effort and lead continually to more success are easiest to learn, particularly when they revolve around meaningful events involving real-world objects and routines (Fletcher, 1992; Nelson, 2004).

Schmidt (1975) suggested four steps that must occur for a child to learn a motor skill. First, the initial proprioceptive conditions (or postural pretraining) for the movement must be met. Second, the child must be able to pull forward the motor plan. Third, the child must be able to recognize if the motor plan was correct or faulty by comparing sensory stimuli (e.g., proprioceptive, kinesthetic, auditory) and, finally, the success of the response in relation to the intended outcome evaluated. Both recall memory, necessary for generating motor commands, and recognition memory, critical for evaluating and comparing the response-produced feedback to derive error information, are needed. Motor learning theory, as described previously, is constantly used by clinicians who use PROMPT. Not only can the motor actions be shaped by using different amounts and types of tactual input, but the ways in which these actions are practiced (e.g., massed or distributed practice; Schmidt & Bjork, 1992; Schmidt & Wrisberg, 2000) can be naturally embedded in age-appropriate activities or routines. Schema Theory and Motor Learning The-
evolved from the most simple, least organized, and least structured and organized to the most complex and organized speech and suggested that the interplay of structural and CNS systems is about by CNS maturation, sensory-motor, and cognitive factors.

The clinician using PROMPT patterns with which the infant/multi-action sets. It is there, the client's developmental stage achieved, ranging from reflex work further reminds us that to the development of some set system does not occur or lesser degrees, the ability for speech and, therefore, the ability to learn and understand, is early as 1920. He proposed process of extracting core reflect rules that have led to the development of effective functional communication. This model addresses all aspects of the World Health Organization's (WHO's) International Classification of Functioning, Disability and Health (ICF) framework (WHO, 2001). PROMPT's conceptual framework reflects the relationship between the environment and the individual, as shown in Figure 19.2. Bidirectional arrows acknowledge that impairment in any one of the domains affects functioning in the other domains in a nonlinear manner.

**Level of Consequences Being Addressed**

The PROMPT approach provides clinicians with tools to assess and treat motor speech disorders from a structural/functional, activity limitations/inclusion, and participation perspective to achieve effective functional communication. This model addresses all aspects of the World Health Organization's (WHO's) International Classification of Functioning, Disability and Health (ICF) framework (WHO, 2001). PROMPT's conceptual framework reflects the relationship between the environment and the individual, as shown in Figure 19.2. Bidirectional arrows acknowledge that impairment in any one of the domains affects functioning in the other domains in a nonlinear manner.

**EMPIRICAL BASIS**

PROMPT was initially devised as an approach for speech production disorders and was not designed specifically for children with speech sound disorders. To date, investigations of PROMPT have focused on how its use of tactile input aids the child or adult in developing, rebalancing, or accessing motor targets of a linguistic nature. Of the nine studies, three have appeared in peer-reviewed journals, one resulted in a master's thesis, four have appeared in peer-reviewed conference proceedings, and one is in preparation for publication. Only studies involving intervention with children by a treating clinician who has had at least some PROMPT training or has met fidelity in the method have been included (see Table 19.1).

The first exploratory (case) study focusing on PROMPT (Sherman & Chumpelik [Hayden], 1981) studied the effects of PROMPT along with behavioral methods for a nonverbal 8-year-old child with ASD and concomitant severe cognitive and behavioral impairments. Prompted stimuli initially included 10 CV and CVC words that could be used by the child with caregivers to indicate basic needs and wants. As the child attained 85%
accuracy over three sessions, new words were added until the end of the 32-session intervention block (2 sessions per week for 16 weeks). Words achieving the 85% criterion could not drop below 75% accuracy or they were added back into the PROMPT condition. All words, in the active and inactive condition, were probed 10 times during each session and were scored online as correct or incorrect by two behavioral therapists. Three measures of agreement of scored responses across the two scorers ranged from 87% to 93%. Results indicated that over the 4-month period, the child acquired 30 intelligible words after no previous interventions had been successful. Staff and caregivers also noted a reduction in problem behavior. At a 6-month follow-up, the parents reported the child's continued use of about 25 trained words, as well as a continued reduction in the frequency of problem behaviors.

In 1984, Chumpelik (Hayden) and Sherman investigated PROMPT's efficacy with two groups of four male participants with severely impaired speech—one group with typical cognition and the other with moderate-to-severe cognitive impairment, as determined
using the Wechsler Intelligence Scale for Children–Fourth Edition (WISC-IV; Wechsler, 2002). Both groups were given traditional auditory-visual (AV) intervention using an integral stimulation approach and PROMPT using a multiple baseline across behaviors design. Each child was administered a probe testing all English phonemes and selected words and phrases. Each phoneme, word, and phrase had been rated by five speech-language pathologists (SLPs) on a 1–4 scale for earliest-to-latest to acquire and easiest-to-hardest to teach. Six error sounds were then selected for each child. Two phonemes were randomly assigned from level one, and three from each of levels two, three, and four for each child. Two nonsense words were constructed for each child from the individual phonemes in their training sets; one word with two phonemes (CV, VC) and one with three phonemes (CVC).

A complete session incorporated 50 trials on each sound and nonsense word. A maximum of 400 trials was presented to each child, with fewer trials used if the child met a criterion of 2 days of 45 correct productions. Fifty trials were presented on the first sound; 50 were then presented on the next, and so forth until 50 trials had been presented on all stimuli. The order of presentation of 50 trial blocks was determined randomly, except that the penultimate block always included the two-phoneme nonsense word and the last block always included the three-phoneme nonsense word. Intervention was administered twice weekly, over a 12-week period, by two SLPs trained in both methods. Each participant began intervention on the first sound with PROMPT while all other phonemes were presented with AV. Once the first sound reached criterion, the next sound was treated using PROMPT and so forth until all stimuli were completed. All 8 participants demonstrated improvement in their randomly selected phoneme and nonsense target words with PROMPT. Although participants with typical cognitive and motor skills demonstrated greater progress in the PROMPT condition than in the AV condition, the children with cognitive impairment demonstrated change only with the addition of PROMPT.

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<th>Level</th>
<th>Description</th>
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<tr>
<td>Ia</td>
<td>Meta-analysis of &gt; 1 randomized controlled trial</td>
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<tr>
<td>Ib</td>
<td>Randomized controlled study</td>
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<tr>
<td>IIA</td>
<td>Controlled study without randomization</td>
<td>Chumpelik (Hayden) &amp; Sherman (1984); Rogers et al. (2006); Square, Chumpelik [Hayden], Morningstar, &amp; Adams (1986); Square et al. 2000</td>
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<td>IIB</td>
<td>Quasi-experimental study</td>
<td>Houghton (2003); Square, Chumpelik (Hayden), &amp; Adams (1985)</td>
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<td>III</td>
<td>Nonexperimental studies, i.e., correlational and case studies</td>
<td>Bose, Square, Schlosser, &amp; van Lieshout (2001); Freed, Marshal, &amp; Frazier (1997); Sherman &amp; Chumpelik (Hayden) (1981)</td>
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<td>IV</td>
<td>Expert committee report, consensus conference, clinical experience of respected authorities</td>
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Adapted from the Scottish Intercollegiate Guidelines Network (http://www.sign.ac.uk).
Studies of PROMPT's Effectiveness with Children

Square et al. (2000) measured PROMPT's effectiveness in treating children with oromotor and sequencing impairments. The participants were six males (ages 4:2 to 4:6) with unintelligible speech who had made minimal progress in traditional therapy. Standardized tests of phonological, motor, language, and social skills were administered before and after intervention. A multiple probe design across behaviors was used to evaluate effects of PROMPT on auditory perceptual and visual speech movement accuracy across two similar sets (A-B) of lexical items. Set A focused on jaw and labial-facial control; set B on lingual control. Motor goals were selected by two investigators for each child based on observations of his speech performances on the VMPAC and a storytelling task. The intervention goals were prioritized using the MSH.

A list of 40 words was generated for each child—20 words were treated and 20 were used to probe generalization. Words were randomly assigned to the training and probe conditions but were matched according to the corresponding motor goals and movement parameters. The 20 trained lexical items were grouped into two sets of behaviors for each child; set A and set B. In each set, there were two subsets of words—one devoted to jaw movements and one to lip movements. The teaching criterion was a maximum of 15 training sessions for each set.

During intervention and maintenance phases, probes were taken every 2–3 sessions. A group intervention paradigm, with four children in each group, was conducted twice per week for 1.5 hours over 12 weeks, or a total of 36 hours intervention time. Sessions followed the same routine: who is here, show and tell, floor time, and storytelling with embedded PROMPT lexicons/motor goals for each child. All children then moved to the table for paper and coloring tasks while one child received individual work. After individual work, the children participated in a story retell or reenactment requiring responses from the children. The PROMPT intervention resulted in significant perceptually improved speech on both auditory and visual measures across both training sets and on untrained or similar words.

Children with severe persistent sound system disorders were studied by Houghton (2008). Five children, ages 3:9 to 9:8 (mean age [MA] 6:0) participated in the study. All children had received a minimum of 1 year of therapy (range 1:1 to 4:0) using a phonological approach and had reportedly made minimal gains. Determination of phonemes to be targeted was established using the Fisher-Logemann Test of Articulatory Competence (Fisher & Logemann, 1971) over three consecutive sessions. Percentage of consonants correct (PCC) was calculated according to Shriberg and Kwiatkowski's (1982) procedure for assessing severity of involvement. A second SLP scored 46.5% of randomly selected samples. Inter-rater reliability for the PCC was 96.5%. Four phonemes that had never been articulated correctly on the test were studied. Two phonemes were selected that differed by more than one feature, for example /tʃ/ versus /s/; and one phoneme was selected that differed by only one feature, for example /p/ versus /b/, to examine within-class generalization. A fourth unrelated phoneme was chosen to act as a control sound. For the two target phonemes, two CV words, two CVC or CVCC words, and one functional phrase containing the target phoneme were developed for training. In the intervention phase, 10 trials for each word/phrase were elicited each session until 80% accuracy was attained on two consecutive sessions, or a total of 8 sessions were completed. Sessions were con-
treated children with oro-
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ducted two times per week for 20–40 minutes. In intervention, each target word/phrase
was presented with an auditory model and an accompanying visual stimulus picture. Only
the target phoneme was scored for accuracy. If the phoneme was judged to be accurate
perceptually, it was scored as correct. If not, the child was instructed to wait while the
SLP provided a surface prompt of the word/phrase. The child was then required to pro-
duce the word while the SLP simultaneously prompted in the word/phrase. One child
failed to complete intervention and a second child was unable to adhere to the interven-
tion protocol. Of the three remaining participants, each showed an overall increase in
control over production of target phonemes, although in some instances there was an ir-
regular profile of acquisition. Spontaneous speech samples taken at the completion of the
intervention phase revealed that five of the six trained phonemes significantly increased
in accuracy of production in both trained and untrained words in conversational speech.
Evidence of within-class generalization also occurred for three participants, whereas
their untrained phonemes remained at 0% accuracy.

A study conducted by Rogers et al. (2006) compared the effectiveness of the Denver
Treatment Model (Rogers & Lewis, 1989) and PROMPT with nonverbal autistic children
2–4 years of age. This single-subject, multiple-probe design across behaviors examined
these interventions for 10 nonverbal autistic boys ages 24–50 months of age, with five
children randomly assigned to each type of intervention. Data for only eight children
(four in each group) are described here because one child in each group made no
changes. All children met the diagnostic criteria for autism on the Autism Diagnostic
Observation Schedule (ADOS; Lord, Rutter, DiLavore, & Risi, 1999), the Autism Diagnostic
Interview–Revised (ADI-R; Lord, Rutter, & Le Couteur, 1994), and the Diagnostic and
Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV; American Psychiatric
Association, 2000); used five or fewer words per day; had a ratio IQ ≥ 35; and had a then-
current nonverbal developmental level of 15 months. Previous time in intervention for
the children ranged from 380–3,400 hours. Standardized test data were collected pre-
and postintervention, then 3 and 6 months later; in addition, random 10-minute probes of each
intervention session were obtained. Intervention coding of the random 10-minute
samples of each session was scored by two reliable observers for the number of words
(or approximations)/phrases produced, as well as function and level of independence. All
four children in the PROMPT condition acquired words over the 12-week intervention
period. The high and moderate responders (MA 23–28 months) increased word output from
less than five words per day to more than 2,000 words per hour and 90 words per hour,
respectively, and were found to use approximately 100–160 phrases per hour by the end
of the 12-week intervention period. The low responders (MA > 13–14 months), who had
averaged no more than three words per day, averaged 10–20 words per hour by the end
of the 12-week intervention period. All children made expressive language gains on the
Mullen Scales of Early Learning (Mullen, 1995). The two high responders made a total of
30 months' gain in expressive language. All but one child made receptive language gains.
The two high responders achieved approximately 20 months' receptive gain over a 4-
month period. Analysis of individual participants' data revealed that children made
changes in both intervention conditions. Interestingly, for children using PROMPT, it
appeared to be most effective for those autistic nonverbal children who were in early lin-
guistic stages (e.g., 24 months) or had motor involvement as well as autism and had made
little or no change with other intervention methods.
PRACTICAL REQUIREMENTS

PROMPT involves work on motor practice embedded into activities involving social interaction and activities of daily living, making sessions a positive and motivating experience for the child, the family, and the clinician. It does not require that families spend large sums of money for frequent and intensive services, with a significant impact having been demonstrated when intervention is administered once or twice per week for 12–16 weeks (Houghton, 2003; Rogers et al., 2006; Square et al., 2000). However, recommended intervention frequency depends on the nature and severity of the presenting disorder. In general, if a child presents with mild-to-moderate cognitive impairments, PROMPT is recommended for a maximum of twice per week in a pull-out condition. For children with moderate-to-severe cognitive impairments, PROMPT would be most effective in the context of a functional environment such as a home, preschool, or classroom. Regardless of the intervention frequency, professionals should begin to see changes in a child's motor speech control and/or language production within four to eight sessions. The rate of change will depend on the level of impairment across domains and the skill level of the clinician. PROMPT can be administered in a group setting as well as in individual sessions. The length of most individual sessions is 30–60 minutes, whereas group sessions can be up to 90 minutes to 2 hours in duration.

Involvement of individuals in the child's environment is another essential component of PROMPT. Support can be recruited from team members, family members, and peers in order to help a child carry over his or her PROMPT lexicon. These people do not need to be trained in PROMPT; instead, they can provide additional, functional opportunities for carryover.

Because PROMPT is administered during functional activities, no specific materials are required. Materials such as toys, books, and academic resources in a typical intervention room, home, or classroom can be used. In addition PROMPT can be implemented during activities of daily living, such as bath time or snack time. For some children, it may be appropriate to send home a book with pictures or words or a game-like activity representing the PROMPT lexicon to aid the family in creating opportunities for carryover. Nonetheless, some materials have been specifically designed for PROMPT, including computer software, stimulus cards, and a web site with additional resources that are available through the SmarTalk web site (http://www.smartalk.info).

Because PROMPT is a holistic framework that requires knowledge of neuromotor principles, including the direct actions, placements, and the amount of contraction and timing changes within and across speech subsystems, becoming a PROMPT-certified SLP requires extensive training, taking 1½ to 2 years and entailing two courses and two self-study projects. In addition, a self-study PROMPT Certification Project is required. (See the PROMPT Institute's web site, http://www.promptinstitute.com, for details.)

KEY COMPONENTS

This section explains the core intervention elements of PROMPT therapy within the PROMPT conceptual framework (see Figure 19.2).
Assessment of Global Domains for Intervention Planning

In order to execute an effective PROMPT program, a clinician should use the Global Domain Profile (Hayden, 2002) to organize the informal and formal assessment data to determine the child's strengths and weaknesses within and across domains. A PROMPT evaluation is structured around critical questions that examine the Cognitive-Linguistic, Social-Emotional, and Physical-Sensory domains. For a detailed description of questions within each domain, see Hayden (2004).

The most critical domain for planning the motor speech aspect of PROMPT is the Physical-Sensory domain. Assessment in this domain requires the clinician to evaluate skeletal structure; general neuromotor control; specific motor subsystem control; the processing of auditory, visual, and tactile sensory input; and the interaction between structure and function, as described in the assessment considerations section of this chapter.

Determination of a Communication Focus and the Uses of PROMPT

Following the Global Domain Assessment, a Communication Focus for intervention is selected. The Communication Focus helps the clinician and the parents/caregivers determine the communicative priorities for the child and provides a context in which to embed motor, language, cognitive, and social interaction objectives. The Communication Focus should center on a specific area of a child's life that will be improved with the intervention (e.g., play skills, interactive routines, self-help skills).

PROMPT can then be used in one of three ways. The first use, to develop an interactive focus/awareness for oral communication, is for minimally verbal children. The second is to develop an association between simultaneous dynamic tactile and auditory input to specific words or concepts. The third use of PROMPT would be to develop, rebalance, or restructure speech subsystems at the sound, word, or phrase level.

Selection and Implementation of Priorities and Motor-Phoneme Targets

After thorough assessment using the SAO and MSH, three motor speech subsystems are selected as the focal priorities for change and must be kept in mind in all intervention activities. Within the three prioritized stages, the clinician determines which motor subsystem should receive the most input, or which plane of movement(s) will be targeted first. To change speech production, the lowest levels need to be developed or refined before independence can be expected at higher levels (Hayden & Square, 1999). The first priority is often the lowest stage that is not functioning adequately. However, the clinician must determine which priority will provide the most stabilizing factor for change.

Priorities are supported primarily through the use of auditory-tactile input consisting of four different PROMPT types (see Table 19.2). In PROMPT, the refinement of motor actions occurs through successive shaping. Shaping involves the reinforcement of each intermediate response that more closely resembles the desired response. Steps used in this process usually entail the following sequence, but may use different PROMPT types, typically applied in varied combinations depending on the child's cognitive and motor resources. For example, the clinician maps in the pattern (i.e., the syllable, word or phrase) while the child is passive, then the clinician either repeats the same pattern or chooses
Table 19.2. PROMPT types

<table>
<thead>
<tr>
<th>Type of PROMPT</th>
<th>Definition of tactual support</th>
<th>Component in Schema Theory (Schmidt, 1975) that is taught</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter PROMPT</td>
<td>Broad-based support for one parameter (e.g., jaw support, broad rounding)</td>
<td>Initial proprioceptive conditions</td>
</tr>
<tr>
<td>Surface PROMPT</td>
<td>Information in one dimension to an articulator to signal place, timing, and transition</td>
<td>Motor plan or basic phonetic sequence</td>
</tr>
<tr>
<td>Complex PROMPT</td>
<td>Information in more than one plane of movement in order to construct a holistic representation of a motor-phoneme</td>
<td>Motor plan for a single sound</td>
</tr>
<tr>
<td>Syllable PROMPT</td>
<td>Combination of Parameter and Surface PROMPT to guide the holistic shape of a syllable and ease the motor load for a child</td>
<td>Initial proprioceptive conditions and motor plan or basic phonetic sequence</td>
</tr>
</tbody>
</table>


an easier variant of the motor pattern and prompts this again while the child participates. Then, depending on the child's accuracy of response, the clinician may repeat the above or reduce the motor pattern further for the child to succeed. The child then says the word again and is verbally reinforced.

As mentioned, a clinician who uses PROMPT is always mindful of motor learning principles, such as including both massed and distributed practice (Skelton, 2004). For example, massed practice may require a child to use the word *up* for each block used to build a tower with blocks. In distributed practice, the targeted word should be embedded within other naturalistic and interactive activities (e.g., cars going *up* and down ramps in a garage) or within a phrase (e.g., using a farm with stairs each animal can go *up*: *cow up, sheep up*). Each PROMPT type provides a different amount of support; they all help a child with one of the four critical elements of learning new motor action sets (Schmidt, 1975). In addition, as mentioned previously, surface PROMPTs can be mapped in before or after the production to help the child recognize if the motor plan was correct or faulty and to evaluate the outcome as compared with the targeted movement. The different PROMPT types are summarized in Table 19.2.

In PROMPT, phonemes are referred to as motor-phonemes because they represent the schema used to plan and execute the production of a sound. The term *motor-phoneme* reflects an individual's dynamic movements that produce the acoustic equivalents used to build words and phrases. A clinician identifies approximately 10 motor-phonemes as part of intervention planning. These phonemes, which are selected from the three priorities previously discussed, must also be able to be combined to produce functional words (i.e., motor action sets) in the prioritized areas. For example, if the first priority of intervention is mandibular control, the clinician may be working to help the child establish typical jaw excursion or reduced lower boundary action during speech production. Motor-phonemes such as /a/ as in *hat* and /æ/ as in *hat* would be selected so that the
child would learn to use them with less jaw opening, thereby promoting initial back tongue contraction. Parameter and surface PROMPTs would be helpful at this stage.

The selected motor-phonemes are then combined to form syllables, word approximations, and words that are referred to as the PROMPT lexicon. It is critical that the words in a child’s lexicon be both motorically achievable and functional so that the improved motor speech control can be used in everyday interactions with parents, caregivers, and/or peers. In addition, for children with impairments in the cognitive-linguistic and/or social-emotional domains, the lexicon can be used to develop skills within these domains. Another important consideration when determining the PROMPT lexicon is to select words that are cognitively and semantically appropriate for the mental age of the child. As a child’s motor speech and language skills develop, the words in the lexicon can be combined for use in phrases. In addition, carrier phrases can be developed in the same plane of movement as the targeted word, thereby reducing the motor load for the child.

Establishing Long-Term Goals and Short-Term Objectives

Next, the clinician who uses PROMPT writes at least three broad, language-based long-term goals that embody the Communication Focus, work to rebalance a child’s functioning across the three domains, and address the three priorities through the selected motor-phonemes and lexicon. Long-term goals help guide a child’s intervention for 6–12 months. For example, if a child’s Communication Focus is play skills, one long-term goal may be, “During constructive activities, the child will use verbal communication to name the parts or request additional pieces” (Hayden, 2006). Up to three specific objectives that identify the observable behaviors are then developed for each long-term goal, including the rebalancing or development of motor speech skills to be learned in intervention. PROMPT short-term objectives may be focused in the Cognitive-Linguistic, Social-Emotional, or Physical-Sensory domains. An essential component of PROMPT is that the clinician embeds motor learning into language objectives that work to strengthen weaknesses in any domain. When writing the objectives, the therapist must continue to think about what skills should be developed in each domain while also addressing the child’s motor speech control by including words and phrases from the planned lexicon. Examples of short-term objectives are illustrated in the case study later in this chapter and demonstrate how a PROMPT therapist can embed motor priorities in a language-based activity to help develop improved phonological, language, and motor speech skills. Generally, depending on the individual child’s disability, short-term objectives are written so that they may be achieved within a relatively short time (i.e., within 1 week to 1 month).

Intervention Sessions

PROMPT sessions include 1) three to four activities, routines, or scripts that reflect the Communication Focus and can be expanded over time; 2) long-term goals and short-term objectives that embed the PROMPT lexicon and MSH priorities; 3) turn-taking between the clinician and child; 4) the use of various levels of PROMPTs to either develop interaction, associate sensory to cognitive-linguistic information, or rebalance, develop, or organize motor speech control; and 5) mass and distributed practice. Portions of a PROMPT session are shown in the accompanying DVD for this book.
ASSESSMENT AND PROGRESS
MONITORING TO SUPPORT DECISION MAKING

Depending on the presenting disorder, there are several ways to monitor intervention progress and make decisions. First, standardized testing, such as the VMPAC (Hayden & Square, 1999) or the DEAP (Dodd et al., 2007), is administered at least three times during the 16-week intervention to see how underlying systems are responding and changing or how motor behavior is being refined. Second, target word sets, selected after determining the MSH priorities for each of the three motor speech subsystems, form the basis or core PROMPT lexicon for intervention and are monitored weekly for change.

Third, a set of untrained probe words can be administered approximately every second or third session throughout intervention. This frequent probing serves to help the clinician 1) monitor the original and changing MSH intervention priorities and ensure that those motor priorities are being met, 2) evaluate how the motor actions (stages) are developing and if they are generalizing to untrained word forms, and 3) support decisions about when to change the level or relevance of the priorities. For example, the first priority may be Stage III, Mandibular. After working on vertical plane movements within words, the child may achieve smooth opening and closing phases with good grading and appropriate range. Then, this priority may drop into third place where it is only monitored and the new highest priority may now become Stage IV, Labial-Facial. If the child achieves 80% accuracy on an untrained probe word set over three consecutive probe sessions, a new motor speech subsystem priority is selected.

The achievement of long-term goals related to the overall Communication Focus and objectives also provides evidence of progress. The following language skills are also monitored on an ongoing basis: syntax and morphology, use of communicative functions, mean length of utterance, and responsiveness to recasts. Finally, as suggested in Schema Theory, recall and recognition memory are checked to see if the child can monitor and self-correct his or her own speech production. This aspect is extremely important because the presence of such skills suggests that the child may no longer need tactile input to make a change in motor actions and can rely solely on auditory, visual, and cognitive-linguistic information to continue learning.

CONSIDERATIONS FOR CHILDREN FROM CULTURALLY AND LINGUISTICALLY DIVERSE BACKGROUNDS

The fundamental principles underlying PROMPT mean that it is inherently flexible and easily adaptable across speech and language systems internationally. PROMPT training manuals (Hayden, 2006, 2008) have been translated into French, German, Dutch, Spanish, Cantonese, and Singlish. Instructional training programs have also been presented to teach PROMPT to SLPs within their home country in the context of their own practice.

Because PROMPT views speech as a linked motor skill, translating it into other languages requires systematic analysis of the multidimensional aspects of speech sound production, as well as how physiological and linguistic development interact to determine first words and early semantic–syntactic relationships in that language. There appear to be universal articulatory preferences in the babble and early speech of young children across languages, which are driven predominantly by oscillating movements of the mandible in combination with static postures of the lips and tongue (McNeilage & Davis,
Early communicative intents and words then appear to be shaped in relation to this developing vocal repertoire (Smith & Goffman, 2004). Therefore not only is the PROMPT technique modified in terms of the actual cues used, but variations also occur in terms of initial lexicon choices in therapy. Because speech production practice in PROMPT is embedded within functional contexts for the child, intervention involves key members of the child’s community, including but not limited to caregivers, teachers, and peers, and communication foci reflect the conversational style and pragmatics of the child’s language. Consequently, PROMPT can be used by clinicians working with children who speak other languages who have a speech sound disorder, as well as with bilingual children who have either a speech sound disorder or difficulty with sounds present in their new, but not their first, language.

CASE STUDY

ZR was a 6-year-old boy with severe speech difficulties in the presence of average cognition and receptive language skills. Early developmental history was unremarkable apart from delayed speech and expressive language mile- stones, with his first intelligible words reported at 2½ years of age. ZR’s past intervention included 12 months of weekly or biweekly individual and group-based speech pathology programs through a community health service and 6 months of weekly, individual speech therapy at school. Sessions ranged from 30–45 minutes in length and focused on improving production of single targets within a traditional articulation hierarchy. Visual symbols and cued articulation were used to support sequencing within words and phrases. ZR’s parents reported only limited gains in speech intelligibility following these interventions. ZR was in first grade at a local public school when first considered for PROMPT.

Global Domains Analysis

ZR was an engaging child who was experiencing academic difficulties and some social isolation at school due to his poor speech intelligibility. He presented with significant difficulties maintaining attention to tasks and struggled to filter relevant from irrelevant stimuli in the environment. In learning situations, ZR was eager to please but impulsive and highly distractible, requiring consistent structure and clear boundaries in order to self-manage his behavior.

Systems Analysis Observation

ZR presented with normal skeletal structure and dentition; however, functioning of individual speech subsystems was significantly impaired. He presented with mild low tone throughout his body. Phonation control and breath support for speech were adequate although he experienced difficulty in timing the closure of the velopharyngeal port in connected speech resulting in resonance issues. Mandibular movements were poorly graded, often too wide and ballistic in nature. Independent lip movement could only be achieved in combination with high front or back vowels, and no individual lip movement was evident. Overall, labial-facial musculature showed poor retraction and protrusion in connected speech. Lingual
Table 19.3. Example of an activity

<table>
<thead>
<tr>
<th>Communication focus</th>
<th>Academic skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal</td>
<td>In academic tasks, ZR will label consonants by name and sound and be able to orally segment and blend sounds in CVC words.</td>
</tr>
<tr>
<td>Activity</td>
<td>Phonological awareness Bingo game</td>
</tr>
<tr>
<td>Objective: physical-sensory</td>
<td>In a Bingo game, ZR will demonstrate reduced jaw movement with controlled jaw gradation when identifying single CVC words on his board on 10 of 12 occasions (e.g., map, hop, bob).</td>
</tr>
<tr>
<td>Objective: cognitive-linguistic</td>
<td>In a Bingo game, ZR will orally blend sounds to identify simple CVC words with a picture cue on 10 of 12 occasions.</td>
</tr>
</tbody>
</table>

movements were accomplished through jaw release with significant recruitment of labial-facial musculature in order to facilitate adequate contraction. Due to these considerable lower-level issues, ZR exhibited significant difficulty sequencing movements across planes, and his prosody was also severely compromised.

Baseline Measures

Baseline data were collected for target words to be used in therapy, and untrained probe words were chosen in order to detect change across untrained vocabulary. Probe words were matched across priority areas (i.e., Mandibular, Labial-Facial, and Lingual control). At the commencement of therapy, ZR’s baseline accuracy rates across parameters for target and control stimuli were 27% and 23%, respectively (see Table 19.3 for example activity).

Probe Data

After 3 weeks and six 30-minute sessions, probe data were collected. Accuracy rates across parameters for target and control stimuli had improved to 47% and 40%, respectively. These results reflected improved grading of jaw movements across both target and control stimuli; however, lingual contractions were still broad for the productions of /l/, /d/, and /n/, and bilabial productions used whole lip rather than the medial one third of labial surface. Objectives were then revised to reflect these new targets: independent lip movement and anterior tongue separation.

Results of Intervention

ZR’s skills were reassessed after 12 weeks of intervention (see Table 19.4). The SAO revealed improved jaw grading, refined labial-facial movements, and true anterior tongue separation. Excessive recruitment of labial-facial movement was still evident for untrained consonants. In addition, lingual contractions for mid-back and back sounds required further development and integration. ZR’s parents commented that unfamiliar listeners could understand more of his speech and it was the first time they had heard him produce words accurately. They also reported that ZR was beginning to show more interest in reading and was keeping up with his peers across most literacy areas. Further therapy was recommended.
Table 19.4. Results of intervention

<table>
<thead>
<tr>
<th>Assessment tool</th>
<th>Pretest results</th>
<th>Posttherapy results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global motor control:</td>
<td>90%</td>
<td>100%</td>
</tr>
<tr>
<td>Focal oro-motor control:</td>
<td>40%</td>
<td>67%</td>
</tr>
<tr>
<td>Sequencing:</td>
<td>22%</td>
<td>65%</td>
</tr>
<tr>
<td>Connected speech:</td>
<td>35%</td>
<td>65%</td>
</tr>
<tr>
<td>Speech characteristics:</td>
<td>66%</td>
<td>80%</td>
</tr>
<tr>
<td>Assessed using 60 SmartCards</td>
<td>26%</td>
<td>65%</td>
</tr>
<tr>
<td>Total score: 12 of 60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentile: 15th</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below average for Grade 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receptive language score:</td>
<td>106</td>
<td></td>
</tr>
<tr>
<td>Expressive language score:</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>Wechsler Intelligence Scale for Children—Fourth Edition (WISC-IV; Wechsler, 2002)</td>
<td></td>
<td>Not reassessed</td>
</tr>
<tr>
<td>Performance intelligence quotient (PIQ); 42nd percentile</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average for age</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

STUDY QUESTIONS

1. What are ZR's strengths and weaknesses across the global domains?
2. Based on your assessment data and your conversations with the family/caregivers, in what interactive Communication Focus would you choose to embed the motor speech goals?
3. Using the SAO and MSII, how is the client's motor–speech system functioning and what are the three initial priorities for therapy?
4. Which motor-phonemes, words, and phrases have you chosen to target as the first priority?
5. What type of prompts will you use to support the motor-to-language connection (i.e., parameter, syllable, complex, or surface) and why?

FUTURE DIRECTIONS

Future studies are underway to examine how priorities are selected within the MSII and how these priorities directly affect progress and change in articulation and phonological abilities. At the time of this writing, two studies are investigating these areas; one study in preparation for publication examined the effectiveness of PROMPT therapy for children with CP presenting with motor speech disorders. This particular study examined both kinematic tracking of articulator changes and how the MSII influenced goal selection and intervention priorities. A second study focusing on the efficacy of PROMPT in treating CAS is being proposed.

Many aspects of PROMPT continue to need efficacy research. First, studies to determine the effect of adding tactical information to support speech actions are needed—
especially in children with CAS, motor speech disorders, and hearing impairment (with and without cochlear implants). These studies in particular need to be supported by kinematic and/or visual tracking instrumentation and combine both instrumental and subjective/perceptual data sets. Two such studies are in progress at the time of this writing.

Another area of investigation involves the frequency of prompting (i.e., the dosage) needed to be most effective; this should be determined for different speech production disorders. Research is also warranted to examine changes across functional domains, even those that are not being directly targeted (e.g., receptive language or improved peer relationships). These changes are often reported and documented in clinical practice. Finally, clinical trials need to be conducted to determine the most efficient interventions for various speech disorders. These could include both phonological and motor-based interventions and measure both language and speech processes.

SUGGESTED READINGS


REFERENCES


and hearing impairment need to be supported by both instrumental and subjective time of this writing. prompting (i.e., the desire for different speech productions across functional domains) language or improved patient in clinical practice. Most efficient interventions for biological and motor-based inter-


