PRINCIPLES AND POSSIBILITIES:

COGNITIVE MOTOR LEARNING, TREATMENT TOOLS, AND DEVELOPMENTAL MOTOR SPEECH DISORDERS

By

CHRISTINA CYNTHIA ROWE

A special project submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE
in
SPEECH AND HEARING SCIENCES

Portland State University
2005

Dedication

This project is dedicated to my grandparents Mildred Hentz and Malcolm F. Hentz. I am eternally grateful for their faith, generosity, and unconditional love.

Acknowledgements

I am thankful to the dedicated staff and faculty of the Portland State University Speech and Hearing Sciences department. Dr. Christina Gildersleeve-Neumann has been a teacher, mentor, adviser, and editor extraordinaire. Ellen Reuler has consistently provided me with the perfect blend of support and challenge as I have developed my clinical skills.

I have been very fortunate in my life. There has always been abundant love and encouragement from God, family and friends. I am grateful to all of the precious people in my life. My Mother has given unwavering support, even when I have wavered. The Boyles have welcomed me with open arms. Dan has been a wellspring of wisdom and good laughs at just the right moments.

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Introduction

Developmental motor speech disorders are some of the many challenging and important areas of study and treatment in the field of speech language pathology. Childhood apraxia of speech (CAS) is one of the more unique, complex, and controversial motor speech disorders for speech-language pathologists (SLPs) to diagnose and treat. Historically, which children should receive the "apraxic" diagnosis, or even the existence of such a disorder, have been a part of SLP and researcher discussions and sometimes heated disagreements (Strand, 2001). Today CAS continues to attract controversy; for example, to this day SLPs, as well as researchers have not agreed upon one common name for the childhood form of the disorder. Some of the commonly used terms are developmental dyspraxia, developmental apraxia of speech (DAS), and articulatory apraxia. In addition the diagnosis and underlying etiology of CAS have been areas of controversy (Hall, 1992; Forrest, 2003).

Although there is no universally accepted definition, description of the disorder or a unanimous agreement for the criteria for diagnosis, most researchers and SLPs today do agree that CAS is a disorder involving the motor processing of speech. The believed level in the system and amount of motor processing involvement in the disorder differs depending on SLP or researcher theoretical perspective.

Researchers and clinicians over the last few decades have begun looking to the cognitive motor learning principles for inspiration and research based guidance in the treatment and study of CAS, and other motor speech disorders. Strand and Debertine (2000) reason, "If there is evidence of motor processing impairment, intervention must address issues related to improving motor skill" (p. 295). The field of cognitive motor learning offers research helpful to researchers and clinicians studying and treating speakers with communication disorders that result from motor impairments, including CAS. This paper examines findings that support clinicians treating clients with CAS and other motor speech disorders to reflect on the subjects of cognitive motor learning, performance and skill.

Over the past few decades a growing interest in the principles of cognitive motor learning has created some important initial research within the speech-language pathology field; however, the definition of, and search for effective training for clients with CAS are subjects of continued investigations. Researchers and clinicians that study and treat individuals with CAS and acquired apraxia of speech (AOS) have developed a number of preliminary methods, techniques and guidelines for using a cognitive motor learning approach. These methods are promising; however a thorough investigation of their application of motor treatment principles has just begun.

The following paper explores some of the well-researched guiding principles of cognitive motor learning, and investigates the use of these principles in the treatment of motor speech disorders of unknown origins such as CAS. Additionally, some current treatment tools for use in clinical sessions, which are available to SLPs through various publishers and researchers, will be reviewed. Through the information, research, and tools that have been discussed, the rationalization for a new treatment tool will be outlined, as well as how it will be developed utilizing the strongest and most practical findings for use in the clinical setting.

Background

Motor speech disorders are generally defined as disruptions in the speech motor control system. Kent (2000) defines speech motor control as "…the systems and strategies that control the production of speech" (p. 391). This process includes the planning, preparations and executions of movements (often called motor programming), which result in contraction of muscles and displacement of speech-involved structures. The speech process represents a unique and extraordinary motor accomplishment. The complexity and rate of production makes speech the fastest of the discrete human motor performances (Kent, 2000).

Motor speech production is a part of an incredibly complex integration of motor, linguistic, acoustic, psychological and cognitive processes. It is impossible to completely separate motor control from the other components. However, for the diagnosis and treatment of speech and language disorders that SLPs provide, it can be invaluable to focus on the areas believed to be most affected, while still considering all possibly involved elements. Consideration of the motor control system can aid in creating a functional, flexible, and individualized diagnosis and treatment program. This paper will explore some treatment possibilities for CAS and other related disorders within the developmental motor speech disorders category suggested by research in the speech-language pathology and related fields.

During the 1960s, researchers in the speech-language field contributed significantly to the understanding of developmental motor speech disorders. Many assessment and treatment strategies for children with motor speech disorders were also being developed during that time. One example of a researcher at the center of this important work was Fred Darley. He is best known for his contributions to the area of acquired neurological communication disorders. Sometimes overlooked is his significant research in speech disorders in children. This included the study of disorders of articulation in children (Moll & Darley, 1960), and CAS (Yoss & Darley, 1974a, b). Strand's (2001) article examines Darley's lifetime contributions in the area of developmental motor speech disorders and the diagnosis of CAS.

The article shows how his work emphasized the importance of refining and improving clinical techniques for differential diagnosis and treatment for complex speech communication disorders in children. Darley was very careful with his use of terminology and nomenclature. In many ways he set a new precedent for the use of clarity in descriptions and differentiations of deficits in the children with speech disorders he studied. His careful research provided a more clear distinction between children with dysarthria and those children with difficulties in the programming and planning process of movement.

Darley was in the center of the apraxia (both acquired and childhood) controversy of the day. His work created strong support for the involvement the motor process difficulties in CAS, and acquired apraxia of speech (AOS). Others insisted it was solely a linguistic disorder. Darley's studies in partnership with Kathe Yoss (1974a, b) investigated CAS characteristics and the speech behaviors influenced by the context of their production. Their work continues to be referenced today as sound support of a motor processing deficit in children who exhibit the speech disorder characteristics of CAS and the severe articulation disorders they outlined in their research.

In current research and clinical practices, there still exist differing opinions about the exact nature of CAS and other developmental motor speech disorders of unknown origin, and what type of treatments are the best approaches (Davis & Velleman, 2000). Because of the many unknown variables associated with CAS and related disorders, researchers and clinicians suggest a range of explanations. Everything from neurological damage, genetic anomalies, to a general language deficit have been suggested as possible etiologies (Davis & Velleman, 2000). As discussed previously, there is no known etiology, as well as no universally accepted definition, description of the disorder, or unanimous agreement for the criteria for diagnosis. Research continues to search for universal diagnostic criteria (Forrest, 2003). In a letter to parents of children diagnosed with CAS published by the American Speech-Language-Hearing Association (ASHA), Hall (2000) comments on the diagnosis saying, "… there is not agreement among speech-language pathologists as to which specific symptoms are a part of

DAS. The presence of some, or many, of these symptoms in the 'cluster' helps the speech-language pathologist make the diagnosis of DAS" (p. 171). Further investigation and appropriate research will be needed to support a more uniform assessment and diagnosis process.

In spite of the controversy and confusion surrounding CAS, most agree that it is a disorder involving the motor processing of speech. The believed amount of motor processing involvement and level of participation in the complex speech system in the disorder differs depending on SLP or researcher theoretical perspectives.

Theoretical perspectives, as well as therapy approaches generally fall within either a purely motor programming view or a purely linguistic view. A motor programming view concentrates on the practicing and learning of the speech movements, while a linguistic approach is focused on learning the "rules" of the language. The majority of researchers and clinicians today embrace some combination of both approaches (Hall, 2000). The controversy lies in the question of what is the optimum focus during treatment and what the actual involvement of the motor and linguistic systems are. In spite of these challenges initial research suggests that many treatments, including important contributions that come from a motor-based approach, are contributing to improvement in the speech of children with CAS and other developmental motor speech disorders of unknown origin (Kent, 2000).

Cognitive Motor Learning

A promising area of research is found in the field of cognitive motor learning, offering helpful possibilities in treatment design to those studying and treating speakers with communication disorders that result from motor impairments (Yorkston, Beukelman, Strand & Bell, 1999). Cognitive motor learning has been studied extensively over time and is much valued and used in the other motor fields such as physical therapy, occupational therapy and the sports sciences. Over the past few decades a growing interest in the principles of cognitive motor learning has created some important initial research within the speech-language pathology field. The following will explore some of the well-researched guiding principles of cognitive motor learning, as well as show some examples of the

applications of these principles to the treatment of CAS and other developmental motor speech disorders found in the speech language pathology research literature.

When looking at the cognitive motor learning research, it is crucial to define the terms motor performance and motor learning. An understanding of the differences, similarities, and relationships between the two concepts is key to clearly implementing the highly researched principles supported by the cognitive motor learning research. Researchers describe motor performance as a person's voluntary production of an action that is observable and is prone to changes in transitory conditions, such as fatigue or physical condition. Motor learning is described by Schmidt & Wrisberg (2004) as "…an internal process that reflects the level of an individual's performance capability for producing a particular movement" (p. 11). Improvement of motor learning and adaptability comes about through performing motor movements multiple times. Seidler (2004) says this about motor learning, "… before learning processes can be engaged, the learner must first detect the existence of some predictable, and therefore learnable pattern or effect, whether this occurs consciously or subconsciously" (p.69). To determine whether true motor learning has occurred, stable levels of motor performance are verified. The signs that an individual has reached the motor learning stage are apparent when he/she performs the movement automatically, accurately, consistently, fluidly, confidently, efficiently, adapts to changing situations, and recognizes errors (MacKay, 1982).

Cognitive motor learning approaches are based on a number of major principles arising from the intimate connection between performance and learning within the context of the individual person learning the motor skill. These principles include; attention, motivation, goal setting, modeling, conditions of practice, knowledge of results, influence of rate, and most importantly, experience (Fletcher, 1992, p.133-134). Experience is gained through practice.

The research in the cognitive motor learning field supports the importance of considering the person receiving treatment, including his/her individual motivation, attention levels and goals (Schmidt & Wrisberg, 2004). Anyone who has been a teacher can identify the key characteristics of the most

productive learners. These include strong motivation, paying attention to tasks, and being goal oriented. Learners feel more motivated, and pay closer attention when they perceive activities as relevant and working toward the goals they wish to achieve. For example, a person with a motor speech disorder will generally be more motivated and willing to pay close attention, if he/she perceives the tasks included in activities during clinic as contributing to the ultimate goal of more intelligible and functional speech (Strand, 1995). Depending on the client, different challenges can arise in this area. Children, still in the maturing process, may have some difficulty staying motivated and paying attention. The cognitive motor learning approach suggests finding ways to help clients to be motivated and attend to activities. Research has found for example that involving clients in the goal setting process, and self-evaluation of own successes can assist in maintaining motivation and attention (Schmidt & Wrisberg, 2004).

There are other ways to help clients with focus and attention. Research supports the importance of considering the load of information a person is processing while trying to master a new skill (Fletcher, 1992). A clinician can aid in this process by encouraging the client to develop a metacognitive and metalinguistic view of his/her speech production. Supporting a client to be more introspective is a key strategy to help the development of appropriate attention skills and better acquisition of skills (Ruscello, 1993). Another support strategy is to present target materials that do not remove the client's attention away from the targeted speech productions. Strand (1995) says, "…the clinician needs to make decisions regarding the complexity of the stimulus and context that take into account a child's processing capacity" (p. 129). For example, choosing target language material that is familiar allows the child to attend to the target articulation task, in part because he/she does not have to focus on the syntactic or semantic content. Any possible activity that may demand dividing or reallocating attention can make the speech production more challenging.

A study by Dromey and Benson (2003) demonstrated the principle of attention when they compared the effects of concurrent tasks during speech production. The subjects were 10 male and 10

female young adult college students with no history of speech, language or hearing disorders. The researchers introduced three different distracter tasks each designed to target different processing resources while the subjects were performing speaking tasks. One was a motor task, the second was a language task and the third a cognitive task. All the distracter tasks had some effect on the performance of the speaking tasks. The motor task data displayed the smallest changes, while the linguistic and cognitive task data showed significant changes in the subjects' production of the speaking tasks. As this and other study findings suggest, it is important to consider the demands of concurrent tasks when working on the motor learning process, especially tasks that ask the speaker to use cognitive and linguistic skills.

From a cognitive motor learning perspective once a client is assessed and the individual needs, motivations, personality and situations are addressed, it is time to begin practicing and working toward the desired motor skill targets. As mentioned earlier, experience or practice is a key aspect of the cognitive motor learning approach. The planning of what type of practice to use, and when, are also important issues to consider when implementing this approach. From a cognitive motor learning perspective practice is not a simple motor performance or repetition of a target skill pattern. Practice is choosing the most efficient process to develop a motor skill and reach the stability of the motor learning stage (Ruscello, 1993). Cognitive motor learning principles emphasize that repetition is still a fundamental part of effective practice. Enough practice trials must be performed for motor learning to occur. In other words, correct speech movements need to be repeated adequately to become automatic processes (Strand, 1995). How those repetitions are organized to create the most efficient practice schedule is the challenge. Research suggests that certain variations of practice promote learning (Schmidt & Wrisberg, 2004). One question confronting clinicians is how to maximize learning when practicing a number of tasks. Research suggests that the sequencing of the tasks can powerfully affect learning. The two variations often discussed in the cognitive motor learning research are: blocked practice and random practice.

Blocked practice consists of repeating one task before moving to the next, while random practice consists of different tasks intermingled during a session. An example of blocked practice in a speech treatment session would be multiple productions of one word or phrase completed before moving on to another, while random practice would entail presenting targets in an unpredictable order. The results of research comparing the two variations show differing effects. Studies have shown random practice produces superior retention learning over blocked practice (Schmidt & Wrisberg, 2004, Wulf, 1991). Interestingly, people using a random practice schedule show less successful performance during practice sessions than those using blocked practice, but show superior retention when tested at a later time. The cognitive motor learning researchers have suggested that this may be a result of the learner going through a process of relearning a task each time it is reintroduced or that the learner is required to use conscious thought with each task during random practice. In contrast, during blocked practice the learner is able to perform a task more automatically after learning it at the beginning stage (Lee, Swinnen & Serries, 1994).

Varied practice has also been shown to be beneficial to learners (Wulf, 1991). Varied practice is described as adaptations of a same general motor program (e.g. using /t/ in different words). This technique contributes to gains in a learner's understanding of the parameters of the correct movement. For example a speaker needs to learn the different productions of /t/ depending on the coarticulatory relationships with other sounds around it, and what is within an acceptable range for appropriate variations. A combination of random and varied practice has been supported by research as helping to support lasting learning (Schmidt & Bjork, 1996). This is important information for SLPs to consider when striving to design efficient and efficacious clinical sessions for motor speech clients.

When designing practice schedules another factor to consider is whether to employ distributed or massed practice. During distributed practice the learner attends shorter frequent sessions, while massed practice is made up of less frequent longer sessions. In the cognitive motor learning research the findings in this subject area have been somewhat controversial, because of confusions about

definitions and differing effects, depending on the type of motor skill being learned. The many variables make comparisons between studies difficult. When the category of motor skill is specified in the research more consistent findings have emerged (Lee, Swinnen & Serries, 1994). Research has suggested that distributed practice is superior for continuous motor skills such as speech production (Yorkston, Beukelman, Strand & Bell, 1999). Although research has just begun to look at this issue in the speech-language pathology field, the findings in the cognitive motor learning studies are intriguing, and suggest further investigation could have important applications for SLPs planning practice schedules for their clients (Ruscello, 1993).

Cognitive motor learning approaches also emphasize the importance of instruction and modeling. Effective instruction is succinct and relevant to the learner. The cognitive motor learning research suggests instructions should be brief, contain only one or two key points, and finer details should build on elementary information presented at the beginning. To support instructions, demonstration of successful performances, commonly know as models, are used during the learning of motor skills. Research supports the effectiveness of modeling if it displays the essential features of the motor skill (Schmidt & Wrisberg, 2004). These features include timing or patterns of a skill that can be observed by the learner through visual and/or auditory means. Research has also found that the type of model can vary the level of observational learning that occurs. As Lee, Swinnen & Serries (1994) explain, the research suggests differences between learning from expert and novice models. They discuss learning occurring with all models, but that there are benefits to each type. With an expert model the learner receives a precise representation of the target. A novice model provides an opportunity for the learner to benefit from the feedback the model is receiving and engages the learner in the problem solving process. This research provides intriguing support for the group model that many SLPs use when treating children with motor speech disorders as both an expert model and novice models are present in these sessions. Cueing techniques that direct the attention of the learner to key components of the modeled motor skill are also supported by cognitive motor learning research. The

combination of effective instruction, modeling and cueing are important tools to aid an individual in learning a motor skill and are often used by SLPs treating clients with motor speech and other communication disorders. The findings in the cognitive motor learning research support the strategic use of these techniques to support motor learning acquisition.

Feedback is another important aspect of cognitive motor learning. Researchers have demonstrated that there are various types of feedback that can be provided to support the learning of motor skills. Broadly, feedback is classified by researchers into intrinsic or extrinsic categories. Sensory information that occurs naturally when an individual is producing a movement is called intrinsic feedback. This intrinsic feedback can come from within or outside an individual's body. The ultimate goal of the cognitive motor learning approach is for learners to be able to learn a target task at the level where they can monitor themselves with their own intrinsic feedback system. Extrinsic feedback occurs when an individual produces a movement and receives sensory information from some outside source. Examples include, comments from a clinician, audio recording of speech, or a scored test. Extrinsic feedback is often divided by scientists into two categories, knowledge of results (KR) and knowledge of performance (KP). KR describes feedback that gives the learner information about the accuracy of a production (e.g. *yes, that was correct*). KP gives the learner information about the performance (e.g. *yes, that time your tongue was behind your front teeth*). The area of research that studies feedback is too complex and extensive to address at this time. However, overall research seems to have generally shown improved motor learning with both types of extrinsic feedback combined (Strand, 1995). As Fletcher (1992) says in his discussion of feedback "KR and KP combined provide opportunity to channel the subject's actions toward explicitly defined goal postures and movement patterns and to evaluate progress and reward successes attained as the subject moves toward targeted temporospatial action patterns" (p.162). As a subject learns a motor skill, properly presented feedback is an important principle to be utilized for effective training.

The cognitive motor learning research has further investigated the optimal presentation of

extrinsic feedback (also called augmented feedback). Researchers and trainers have often operated from the instinctive assumption that the results from immediate and consistent feedback will be most effective, but findings have not supported this belief. Much like the findings in the comparison between blocked and random practice, immediate and consistent feedback may show more successful performance during practice sessions, but shows inferior retention when tested at a later time (Schmidt, 2004). The findings have supported the need for a more sophisticated set of guidelines for best use of augmented feedback that supports retention of the new skill. Research supports the presentation of feedback that is delayed by several seconds, is summarized at optimal intervals and the relative frequency is faded over time (Lee, Swinnen & Serries, 1994). Overall the findings have suggested that there are ways to maximize the use of feedback to work most efficiently toward the ultimate goal of helping the learner to gain independence from the need for extrinsic feedback and able to rely solely on their own intrinsic feedback system (Lee, Swinnen & Serries, 1994). The cognitive motor learning literature that has investigated the best use of feedback certainly offers valuable information that deserves consideration by SLPs designing sessions with clients who are receiving treatment for motor speech disorders.

Ultimately, the goal of the principles of cognitive motor learning is to support the most efficient, effective, and stable acquisition of a motor skill. The sequential, dynamic and reliable nature of cognitive motor learning principles makes them acknowledged allies for those treating and studying motor speech disorders.

Possibilities

In the speech language pathology field the definition of, and search for effective training of motor speech disorders are subjects of continued investigations. As mentioned previously, some researchers and clinicians over the last few decades have begun to look to cognitive motor learning principles for guidance and new creative researched based approaches in the treatment and study of CAS and other motor speech disorders. As Robin (1992) concludes in his discussion of treatment for

CAS, "…clinicians should carefully construct programs based on principles of motor learning…" (p. 21). Researchers and clinicians using cognitive motor learning principles while studying and treating individuals with CAS, AOS and other speech motor disorders have developed a number of methods, techniques and guidelines. Some well known published methods and techniques include Integral Stimulation, Melodic Intonation Therapy, Prompts for Restructuring Oral Muscular Phonetic Targets (PROMPT), and the Touch-Cue method. An overview of these techniques and methods will follow, as well as some additional suggestions and findings by researchers from the speech language pathology field, which have utilized and/or offered strong arguments for the use of the cognitive motor learning in the treatment of children with CAS and other developmental motor speech disorders.

Melodic Intonation Therapy (MIT) was originally developed for the treatment of AOS. MIT therapy is a combination of techniques including "…melody, intonation, stress, rate control, and manual sign language" (Helfrich-Miller, 1994, p. 176). MIT was first introduced for use with CAS in 1980 by Kathleen Helfrich-Miller. In her 1994 article she discusses the use of this therapy technique with CAS and gives a clinical perspective on how it can be implemented. She emphasizes the need to modify and integrate the methods into other therapy approaches. She suggests, "It is not designed to replace other therapy approaches but to supplement and augment them" (p. 175). Although not specified, some of the MIT design utilizes cognitive motor learning principles. The focus is on systematic practice of motor patterns and conscious attention to the motor production of speech sounds. MIT is a useful example of a therapy approach that utilizes some of the cognitive motor learning principles and can be adapted to the individual needs of a client.

Another of the methods of treatment that is used by some SLPs to treat CAS is the PROMPT system of therapy. This program has received national attention, and contains some of the cognitive motor learning principles. The method was organized formally in 1980 by Deborah Chumpelik. She created the system based on her previous clinical experience and theoretical beliefs. In an article about the PROMPT method published in 1984 she presents a theoretical framework for CAS as a movement

disorder as a neurophysiological process and discusses "…models of speech-motor control and sensory feedback that appear to be stimulated when using this approach." (p. 139). The PROMPT system is focused on using the principles of cuing and phonemic targets in a systematic way. The clinician is instructed to present an individualized series of targets with appropriate tactile, visual and auditory cues and feedback. The program has invited some controversy of late due to the high price of the training program and a lack of independent research based findings to support claims. However, many clinicians have reported anecdotal cases of successes using the system. Further investigation of how cognitive motor learning principles play into the design and results of using the system would be of value to clinicians considering the PROMPT program for their clients.

The Touch-Cue method is another motor-based technique developed for use in treatment for CAS. The method is a direct systematic approach to articulation learning. There are three stages that present exercises of increasing complexity and difficulty. Bashir, Grahamjones & Bostwick (1984) describe the process explaining, "progression from one stage to another occurs slowly and overlearning at any one stage is encouraged" (p. 128). Many of the principles of cognitive motor learning are noticeable within the method although they are not directly referred to. The principles integrated into the approach include; verbal, visual and tactile cuing, random, multiple practice opportunities of target speech sounds, skilled use of extrinsic feedback, and encouragement of the child's development of his/ her own intrinsic feedback system. Although there has not been extensive research into the effectiveness and efficacy of this method, the inclusion of many established principles of cognitive motor learning and traditional articulation therapies suggest it holds promise and possibilities as a clinical tool.

Integral stimulation intervention also approaches the treatment of CAS from a motor perspective and integrates many of the principles of cognitive motor learning (as with the other methods discussed, minimal direct reference to the principles of cognitive motor learning and research is provided). Integral stimulation was first published by Rosenbek, Lemme, Ahern, Harris, and Wertz

(1974) as a treatment protocol for the treatment of AOS. Since that initial article research has continued. Researchers and clinicians have modified the original treatment to apply to the treatment of CAS as well as AOS. A recent published multiple baseline single case study by Strand & Debertine (2000), explored the efficacy of integral stimulation intervention with a 5-year-old female subject. They followed the principles of cognitive motor learning when designing the treatment program. The sessions were distributed rather than massed. The stimuli were presented in a variable fashion instead of blocked. They helped to gain the subject's attention and motivation by choosing target utterances that were functional for her. They lightened the processing load, especially in the beginning, by using phonetically simple targets. Most of all, they followed the cardinal principle of cognitive motor learning; repeated practice of the movements.

Results of the study showed improved production of the targets and improvement in non-treated probes as well. The findings suggested that motor learning had occurred for the subject. Although this study was with a single subject, the results are encouraging and as the authors say, "it is important to continue this work, designing programmatic research to examine the individual effects of a number of motor learning variables (i.e. random versus blocked practice, schedules of feedback, etc.)" (p. 299).

Edythe Strand of the previously discussed study is a researcher who has been at the forefront of recent investigations into the use of cognitive motor learning principles in the treatment of motor speech disorders in children. Her 1995 article with coverage of this subject provides a useful description, and a sound argument for the consideration and integration of cognitive motor learning principles in the treatment planning process. From her research and experience with treatment of children with motor speech disorders she offers what she sees as the most salient issues to consider. These issues include many of the principles of cognitive motor learning including, consideration of attention, repetitive practice and proper use of feedback. She discusses the importance of getting "…the child to take increasing responsibility for assembling and retrieving motor plans with progressively less cuing" (p. 132). Although she recommends the systematic use of those principles she also points out

that further research is needed for more clarity about treatment efficacy for developmental motor speech disorders.

Ruscello (1993) is a clinical researcher who has convincingly argued for the use of the cognitive motor learning principles in treatment for children working on motor skill acquisition. He starts his discussion of the use of the principles saying, " Initially a learner must plan, execute the movement pattern, and assess feedback and evaluation information" (p. 107). He designates the beginning conscious levels of learning "the cognitive stage". He continues by saying, "after the conscious control of practice with appropriate feedback and/or knowledge of results… practice continues to be important in refinement and automatic execution of the motor skill under various contexts and situations" (p. 107). He then presents a detailed treatment plan for a child with significant "sound system errors".

He provides research to support his treatment ideas and program, but does not design a study to collect and examine results. He comments on his treatment program saying, " the procedures I have proposed based on motor skill learning principles, are supported by considerable evidence that such treatment is effective" (p. 116). Although his confident comments may be somewhat premature without a large body of research specifically in the use of cognitive motor learning for motor speech disorders, there is an established research base in other related fields that supports the integration of the cognitive motor learning principles in all motor based skills. Certainly speech has a known significant motor basis.

Overall, the preliminary research that has studied the motor approaches to treatment for developmental motor speech disorders that utilize the cognitive motor learning principles show promise, but much more research will be needed to discover more about the specific nature of the best application of cognitive motor learning principles to speech language pathology treatment. The findings thus far do provide valuable and compelling information for the SLP treating individuals with CAS, developmental speech disorders and any disorder that involves the motor speech system. The

enormous body of research in the cognitive motor learning field can be an indispensable resource to help inspire and guide clinicians and researchers in the speech-language field in the ongoing search for the most effective and efficient treatment. The following project seeks to provide a simple, easy to use tool to aid the SLP providing treatment that will incorporate the previously discussed cognitive motor learning principles into current treatment practices for children with CAS and related developmental articulation disorders. A discussion of the results and future possibilities of using cognitive motor learning principles in the treatment planning for motor speech disorders also follows the review and tool development process.

Method

Overview

Currently available published clinical tools and programs developed and recommended for use by SLPs during the treatment of CAS and related developmental motor speech disorders were reviewed. Published items were chosen from the products offered by a variety of nationally known publishers in the SLP field. The selection criterion for items to review was, that they were described as based on a motor planning theoretical basis and integrated some of the principles of cognitive motor learning. A representative sampling of published items was described including how they utilized the cognitive motor learning principles. An overview of the characteristics, similarities and differences between the reviewed tools and programs was discussed.

A new clinical tool for treatment with CAS and related motor speech/ articulation disorders was developed using the principles cognitive motor learning as a foundation. The reasoning and description of the tool development were illustrated and a prototype of the tool was constructed.

Procedures

Treatment materials designed for the treatment of CAS and severe articulation disorders were selected. The ASHA Leader buyer's guide (2003) was used to identify recommended publishers of materials to assist in the treatment of CAS. Two well-known national publishers were chosen (LinguiSystems, Inc., Super Duper Publications, Inc.). Samples of popular treatment materials for CAS from each publisher were used. The products reviewed were Moving Across Syllables (Kirkpatrick, Stohr, & Kimbrough, 1990), Easy Does it (Strode, & Chamberlain, (1993), and Becoming Verbal and Intelligible (Dauer, Irwin, & Schippits, 1996). Each treatment material product was reviewed using the following procedure. A checklist of cognitive motor learning principles and a qualitative analysis were completed for each product. An overall descriptive comparison between the products was completed, including the similarities and differences between them.

The cognitive motor learning checklist included the following principles: use of random,

blocked, varied and distributed practice schedules, attention, motivation, goal setting, cuing, modeling (novice and expert), intrinsic feedback, extrinsic feedback (KP, KR, delayed, faded, and summarized), and experience (multiple practice opportunities). Each sample product was examined and received a "check" if it directly integrated a cognitive motor learning principle on the list, instructed the clinician on how to employ the principle when using the product, or if it did not utilized that principle. A scale from one to five was also scored for each principle used or employed by the product. One represented a minor use of the principle; three represented average, while five showed a significant use of the principle. The checklist was scored by the author for each product. A general description of the design, materials and instructions provided in each of the products was completed. A comparative analysis was made between them. The overall similarities and differences in the way they did or did not utilize the cognitive motor learning principles was examined.

Upon completion of the examination procedure of the current product samples, a new treatment tool was created. The design of the new tool was based on the findings from the existing products analysis. The main objective of the new treatment tool was to help clinicians maximally utilize as many principles of cognitive motor learning as possible.

The other design goals were ease of use and flexibility for a variety of clients. The tool was created to be used as an adjunct or "overlay" to existing treatment practices, products and materials commonly used by SLPs for CAS and other related motor speech and articulation disorders, such as the products examined previous to the new tool development.

Prototypes of the two worksheets were created to be used during treatment planning and delivery. One worksheet was designed to help clinicians utilize the cognitive motor learning principles of motivation, goal setting and intrinsic feedback. It was created to encourage the client to be moving toward self monitoring and creating the desired motor movements independently. A second worksheet was designed to assist clinicians in monitoring use of the principles the principles of instructions, attention, motivation, blocked, random variable and distributed practice schedules, experience,

modeling (novice and expert), cuing, and extrinsic feedback (KP, KR, delayed, faded, and summarized). The tracking sheet was created to allow for individualized treatment and encourage strategic treatment design.

Results

Overview

Three treatment tools intended for use with children diagnosed with CAS and related motor speech disorders were analyzed using the process discussed in the methods section. The following section will describe findings for each of the treatment tools. A checklist of the cognitive motor learning principles found to be used in each tool was completed followed by a description of the treatment tool and their use of the principles. A discussion of the principles integrated into the tool are discussed first, instructed second, and finally principles not utilized are listed as well. Integrated principles were the cognitive motor learning principles that were an integral part of the actual design of the program and materials. Instructed principles were cognitive motor learning principles that were included in the descriptive text of the tool. Principles not utilized were cognitive motor learning principles not identified in the text or integrated into the design of the treatment tool. The relationship of the treatment tool design and each of these cognitive motor learning principles was considered and described.

Principles Analyzed

The cognitive motor learning principles included in the analysis process are shown on the following page.

PRINCIPLE	DESCRIPTION
Blocked practice	Deliberate and systematic use of repeated production of a target speech sound movement (e.g. same target in isolation until able to produce consistently).
Random practice	Deliberate and systematic production of several targets in an unpredictable order.
Variable practice	Adaptations of a same general motor program (e.g., /t/ is different words and positions).
Distributed practice schedule	The learner attends shorter more frequent sessions.
Experience	Sufficient practice trials must be performed for motor learning to occur.
Modeling	A person providing an example that presents the timing or patterns of a skill that can be observed by the learner through visual and/or auditory means. (With an **expert** model the learner receives a precise representation of the target. A **novice** model provides an opportunity for the learner to benefit from the feedback the model is receiving and engages the learner in the problem solving process.).
Cuing	Techniques that direct the attention of the learner to key components of the modeled motor skill.
Instructions	Effective instruction is succinct and relevant to the learner. (The instructions should be brief, contain only one or two key points, and finer details should build on elementary information presented at the beginning.)
Attention	Target materials that do not remove the client's attention away from the targeted speech productions (this is a broad subject area, so the specific aspect listed was the focus of this analysis).
Motivation	Treatment designed so that client perceives the tasks included in activities during clinic as contributing to the ultimate goal of more intelligible and functional speech.
Goal setting	Goals designed with client input so that they are working toward goals the learner wishes to achieve.
Intrinsic feedback	The ultimate goal of the cognitive motor learning approach is for learners to be able to learn a target task at a level where they can monitor themselves.
Extrinsic feedback	Knowledge of results **(KR)** feedback that gives the learner information about the accuracy of a production (e.g. *yes, that was correct*). Knowledge of performance **(KP)** gives the learner information about a performance (e.g. *yes, that time your tongue was behind your front teeth*). Presentation of feedback that is **delayed** by several seconds, **summarized** at optimal intervals, and the relative frequency is **faded** over time.

Moving Across Syllables

Description

Moving Across Syllables: Training Articulatory Sound Sequences (MAS) (Kirkpatrick, Stohr, & Kimbrough, 1990) was "…designed for use with children age three to ten who have difficulty executing sequenced movements in words." (p.1). MAS was created to be used as a therapy tool with a non-standardized test component and guidelines for treatment. The manual contains chapters describing the origins of the program, purposes and objectives, components of the program, testing administration and scoring, selecting treatment goals, training instructions, and generalization activities. Appendixes are also included with numerous reproducible forms for evaluation and treatment purposes. Lists of words with and without black and white pictorial representations organized by place of articulation, syllable length, and "movement sequences" are included. A separate test booklet to be used with the testing procedures described in the therapy book is provided as well.

Application of cognitive motor learning principles

The sections following Table 1 review and expand on the results of the cognitive motor learning principles checklist findings for the integrated, instructed and not utilized principles in the MAS program. Table 1 summarizes this information on the following page.

Table 1
Cognitive Motor Learning Principles
Checklist

Product Name: Moving Across Syllables (Kirkpatrick, Stohr, & Kimbrough, 1990)

Instructions: Review treatment product. Mark all that apply.

Not Utilized= principle not included Instructed= included in directions Integrated= principle is part of design

Principle ***For definitions: see results section (principles analysed)***	Not Utilized	Instructed	Integrated	**Level of use** **1=minor 3=average 5=significant**
Practice/Conditions				Leave blank if not utilized
Blocked			X	**1 2 3 4 5**
Random			X	**1 2 3 4 5**
Variable	X			**1 2 3 4 5**
Distributed	X			**1 2 3 4 5**
Experience	X			**1 2 3 4 5**
Modeling				
Novice	X			**1 2 3 4 5**
Expert		X		**1 2 3 4 5**
Cuing		X		**1 2 3 4 5**
Instructions	X			**1 2 3 4 5**
Attention		X		**1 2 3 4 5**
Motivation		X		**1 2 3 4 5**
Goal Setting		X		**1 2 3 4 5**
Intrinsic Feedback		X		**1 2 3 4 5**
Extrinsic Feedback				
KR	X			**1 2 3 4 5**
KP	X			**1 2 3 4 5**
Delayed	X			**1 2 3 4 5**
Faded	X			**1 2 3 4 5**
Summarized	X			**1 2 3 4 5**

Integrated principles

The use of blocked and random practice was analyzed. By design the treatment materials encourage the use of both random and blocked practice opportunities. The word lists and illustrations are grouped in families of sounds and movement sequences. For example a sheet of words with pictures will have same movement sequence and syllable shape, but different combinations of sounds

(money, mitten, peanut, penny). However, there are no instructions included in the manual to guide clinicians in the most effective use of these principles.

Instructed principles

Expert modeling and cuing were found in the program directions for use. The section that describes the use of cuing in the MAS system briefly mentions the use of clinician modeling of the targets and encouragement of client imitation. A lengthy section describing their recommendations for use of cues is included in the MAS therapy manual. The cuing system includes three procedures: consistent cuing, fading of cues, and intermittent cuing. During each procedure tactile, visual and auditory cues are used systematically.

The motivation principle was also included in the program directions. A discussion of the importance of making therapy "… creative, individualized and interactive…" A list of ideas for making activities "more fun" is provided. They recommend including words and phrases that are functional for a client and relate to their everyday lives (e.g. name of friends).

Goal setting suggestions were provided. The MAS program was designed to begin with using the testing procedure. After reviewing results of the testing a guideline for choosing treatment goals is provided. The syllable level, movement category and movement sequences are selected based on the percentages received by the clients. Other factors to consider in selection of goals are also discussed, including the frequency of occurrence of a phoneme, stimulability, developmental appropriateness and functional relevance. A chart to help in the goal selection process is provided as well.

Intrinsic feedback was minimally included in the program text. Only one mention was noted related to a child developing self monitoring skills. They instruct clinicians, "do not discourage self cuing since it suggests an awareness of the helpfulness of cues and can be a means for the child to assume responsibility for self-monitoring." (p. 24). *Principles not utilized*

There was no obvious mention, instruction, integration or use of the cognitive motor learning principles of variable or distributed practice schedules, experience, novice modeling, instructions,

knowledge on results (KR), knowledge of performance (KP), delayed, faded, or summarized feedback.

Easy Does It

Description

Easy Does It (EDI) for Apraxia and Motor Planning (Strode, & Chamberlain, 1993) program was the second product to be inspected. The EDI program includes two booklets, a therapy manual and a materials book. The therapy manual contains chapters that provide an introduction, a discussion of successful strategies, vocabulary definitions and an outline of goals and objectives plus detailed explanations of goals. Eleven appendices and references are also included in the therapy manual. The materials book contains reproducible black and white line drawings to support activities suggested in the therapy manual. The EDI program materials book contains worksheets, vowel trading cards, consonant trading cards and badges. A compact disc (CD) copy of the materials book to be downloaded on a computer is also provided.

The EDI therapy manual begins with an outline of goals and objectives for the program. The six goals are separated into smaller objectives. A discussion of the goals will be discussed in a later paragraph. The introduction chapter begins with a description of the population the program was designed for. The population is described as 4 - to12 - year old students diagnosed with "DVA" and/or, "…don't show progress using traditional articulation or phonology approaches, demonstrate subtle or more evident motor planning deficits affecting speech, progress slowly and can't carryover speech and language skills they have learned, may be intelligible at word or phrase level, but lose intelligibility at the sentence level, have increased errors when using complex phonetic combinations, have delays in development of speech and expressive language" (p. 6). A brief paragraph discusses how the program is similar and different to Van Riper articulation therapy and phonology therapy. They note that particular speech sounds are targeted in a progressive order (in isolation up to sentence level) like traditional articulation therapy, and sound classes are targeted as in phonology therapies. The difference from the two approaches is explained as, "…the emphasis is on developing sound sequencing skills and

closed syllables in increasingly more complex tasks" (p 6).

The components of the therapy manual of EDI program are also described in the introduction. The components covered are, successful strategies, goals and objectives, tips, activities, action activities, hand signal descriptions, vocabulary definitions, vowel checklist, therapy tracking sheet, lesson plan, consonant-vowel-consonant (CVC) word lists, nonsense creatures, multisyllabic word lists, multisyllabic word pictures, two and three word phases and sentences list, and references.

The therapy manual appendices A-K descriptions are as follows. Appendix A is a checklist to monitor a student's use of vowels. Appendix B includes descriptions of the program's recommended hand signals for vowels and consonants. Appendix C and D include a consonant inventory checklist and therapy tracking sheet. Appendix E offers a blank lesson plan sheet and a sample. Appendix F lists black and white saggital view drawings of anatomical placement of oral articulators for consonant sounds. Appendix G has line drawings of nonsense creatures to use when working on nonsense sounds in therapy sessions. Appendix H lists consonant-vowel-consonant (CVC) words based on place or manner of articulation (e.g. bilabial-alveolar, liquid-strident). Appendix I lists multisyllabic words. Appendix J contains multisyllabic word pictures. Finally Appendix K lists two and three word phrases and sentences.

Application of cognitive motor learning principles

The sections following Table 2 review and expand on the results of the cognitive motor learning principles checklist findings for the integrated, instructed and not utilized principles in the EDI program. Table 2 summarizes this information on the following page.

Table 2
Cognitive Motor Learning Principles
Checklist

Product Name: Easy Does It for Apraxia and Motor Planning (Strode, & Chamberlain, (1993)
Instructions: Review treatment product. Mark all that apply.

Not Utilized= principle not included Instructed= included in directions Integrated= principle is part of design

Principle ***For definitions: see results section (principles analyzed)***	Not Utilized	Instructed	Integrated	**Level of use** **1=minor 3=average 5=significant**
Practice/Conditions				Leave blank if not utilized
Blocked		X	X	**1 2 3 4 5**
Random		X	X	**1 2 3 4 5**
Variable		X		**1 2 3 4 5**
Distributed		X		**1 2 3 4 5**
Experience		X		**1 2 3 4 5**
Modeling				
Novice	X			**1 2 3 4 5**
Expert		X		**1 2 3 4 5**
Cuing		X		**1 2 3 4 5**
Instructions		X		**1 2 3 4 5**
Attention		X		**1 2 3 4 5**
Motivation		X		**1 2 3 4 5**
Goal Setting			X	**1 2 3 4 5**
Intrinsic Feedback	X			**1 2 3 4 5**
Extrinsic Feedback				
KR		X		**1 2 3 4 5**
KP	X			**1 2 3 4 5**
Delayed		X		**1 2 3 4 5**
Faded		X		**1 2 3 4 5**
Summarized	X			**1 2 3 4 5**

Integrated principles

Goal setting. Each of the six goals is listed in the therapy manual with tips and sequential objectives to work toward goals with instructions for supporting activities and corresponding materials in complementary book. For example, goal one says, "Your student will consistently produce vowel sequences and isolated consonants" (p 15). The objectives for goal one are, "your student will produce vowel sequences. Your student will consistently produce isolated consonants he already uses. Your student will consistently produce new consonants in isolation" (p 16-23). Each objective includes instructions on how to work toward the goal, which materials to use, and the steps of implementation. The remaining goals of the program two through six are listed as, "Your student will combine consonants and vowels in form syllables, Your student will produce one-syllable words using consonant-vowel-consonant (CVC) combinations, Your student will produce multisyllabic words, Your student will produce phrases and sentences, Your student will produce consonant blends in words" (p 4-5). Although there is a significant discussion of goals and guidelines for implementation, there is little discussion of getting the client involved in the goal setting process.

Instructed principles

Blocked, random, distributed and variable practice were discussed in the program directions. In the successful strategies chapter the authors briefly discuss short daily practice sessions spaced apart are more important than long practice sessions. There is no mention made of the rationale for using this strategy. They make several mentions of the benefit of targeting several levels of targets simultaneously. As with the MAS program, by design the treatment materials encourage the use of both random and blocked practice opportunities. The word lists and illustrations are grouped in families of sounds and movement sequences.

Experience was minimally discussed. The program briefly instructs clinicians to provide multiple practice opportunities in order to work toward optimal performance on each objective.

Expert modeling was also minimally included in the program discussion. A few brief

instructions are included in the therapy manual, which encourage the clinician to provide modeling of targets and encourage imitation.

The principle of cuing was found to be a significant part of the therapy tool instructions. The program emphasizes using a multisensory approach. For example, have the child listen to own productions (auditory), use pictures to represent sounds (visual), touch the articulators or the client to indication where the sound is made (tactile), have student make a hand signal while saying word (kinesthetic).

Instructions were minimally discussed in the program. With each objective within the program there are some ideas for how to provide effective instructions for each activity and the speech sound targets.

The attention and motivation principles were addressed in the text. The program recommends structuring therapy so the student is successful, and to work with classroom teacher. The use of real objects and activities with beginning therapy sessions with younger or developmentally delayed students, and use of fun dialogue when introducing each activity is also encouraged.

Some components of extrinsic feedback were included in the program directions. Throughout the manual clinicians are encouraged to use knowledge of results (KR) feedback for children during treatment. Included in the tips sections in the therapy manual clinicians are encouraged to provide feedback consistently at the start and begin to delay time before providing KR and to slowly fade over time.

Principles not utilized

No obvious mention, instruction, integration or use of the cognitive motor learning principles of novice modeling, intrinsic feedback, or knowledge of performance (KP) or summarized feedback.

Becoming Verbal and Intelligible

Description

The Becoming Verbal and Intelligible (Dauer, Irwin, & Schippits, 1996) product is described as a functional motor programming approach (FMPA) for children with developmental verbal apraxia. Three speech language pathologists from the Midwestern United States with "67 years experience" developed the FMPA. It was "…designed for use with children ages 2 to 10 who demonstrate significant difficulty with motor planning for sound and syllable production" (p.1). The program is included in one spiral bound manual with chapters describing the rationale and principles behind the FMPA, how to plan and monitor therapy with their approach, techniques and suggestions to use during therapy, parent information and discussion, and reproducible word lists, "functional pictured words", and data recording charts. The FMPA emphasizes parental and family involvement in the therapeutic process. When advising clinicians using the approach they say, "it is your role to identify each child's particular skills and deficits and determine which of our principles are applicable" (p. 10)

Application of cognitive motor learning principles

The sections following Table 1 review and expand on the results of the cognitive motor learning principles checklist findings for the integrated, instructed and not utilized principles in the MAS program. Table 1 summarizes this information on the next page.

Table 3
Cognitive Motor Learning Principles
Checklist

Product Name: Becoming Verbal and Intelligible (Dauer, Irwin, & Schippits, 1996)

Instructions: Review treatment product. Mark all that apply.

Not Utilized= principle not included Instructed= included in directions Integrated= principle is part of design

Principle For definitions: see results section (principles analyzed)	Not Utilized	Instructed	Integrated	**Level of use** **1=minor 3=average 5=significant**
Practice/Conditions				Leave blank if not utilized
Blocked		X		**1 2 3 4 5**
Random		X	X	**1 2 3 4 5**
Variable		X	X	**1 2 3 4 5**
Distributed	X			**1 2 3 4 5**
Experience		X	X	**1 2 3 4 5**
Modeling				
Novice	X			**1 2 3 4 5**
Expert		X		**1 2 3 4 5**
Cuing		X		**1 2 3 4 5**
Instructions	X			**1 2 3 4 5**
Attention	X			**1 2 3 4 5**
Motivation		X		**1 2 3 4 5**
Goal Setting		X		**1 2 3 4 5**
Intrinsic Feedback		X		**1 2 3 4 5**
Extrinsic Feedback				
KR		X		**1 2 3 4 5**
KP		X		**1 2 3 4 5**
Delayed	X			**1 2 3 4 5**
Faded	X			**1 2 3 4 5**
Summarized	X			**1 2 3 4 5**

Integrated principles

Strategic use of blocked, random and variable practice schedules are an integral part of the program. Instructions were also provided and are discussed in the following paragraph. The general order of the words ranges from VC and CV syllables to verb and noun phrases with increasing complexity. The eight pictures per 8 ½ by 11 inch page are black and white line drawings with the

English word at bottom of each box. The transition between places of productions is also addressed in first three of the groupings. For example, group one contains transitions to a bilabial production. Group four (fricatives) is the exception and is based on manner of articulation rather than place. Seven line drawings portraying familiar themes (e.g. a supermarket) are also provided to target multisyllabic words in connected speech. The program emphasizes the importance of practice and experience in order to learn motor movements and work toward more complexity.

Instructed principles

A discussion of blocked, random and variable practice was provided. The program provided instructions for strategic use of nonsense syllables. The approach was designed to be multiphonemic in nature, focusing on many phonemes and sounds simultaneously, and concentration on correct production of consonants and all vowels. Phoneme selection is recommended to be made with stimulability and developmental considerations in mind. The FMPA was designed to facilitate motor planning by making frequent use of emphasizing transitions between sounds, progressive length and complexity of syllables within a focus on slow systematic progress in therapy. The complexity and target combinations increase in length gradually over 18 “therapy tasks”.

Each therapy task has a corresponding stimulus and response, reinforcement and modification listed. For example therapy task 12, with corresponding stimulus and response, reinforcement and modification respectively say, “Spontaneous production of CVC combinations. Provide a picture or object or demonstrate an action; ask the child a question (such as, “What do we sleep in?”); child responds. Tangible reinforcement. Provide a verbal model and have a child imitate as needed.”

The principle of experience was also discussed. The approach stresses the need for multiple opportunities for experiences with accurate articulatory productions. Throughout the manual mention is made of the importance of repetition and practice.

Expert modeling was included in the program discussion. The FMPA was designed to facilitate motor planning by making frequent use of expert modeling. Clinicians are encouraged in several

sections to provide models for clients to imitate during implementation of the program. They emphasize providing plenty of modeling of targets in the beginning stages of learning something new. They made no mention of utilizing other children in therapy that provide novice modeling opportunities.

The principle of cuing was found to be a significant part of the therapy tool instructions. Multimodality cuing strategies are included in the general principles of the FMPA. In the fifth chapter the authors say, “we strongly advocate a multimodality approach that makes use of tactile, visual, and auditory modalities. Visual, tactile, and auditory cures are extremely important in helping the child achieve success in therapy, and initially we recommend the simultaneous use of all three modalities” (p. 27). Clinicians, parents and children are encouraged to use the same cues.

The principle of motivation was also included in the program instructions. The authors report the approach was designed to be functional in nature. The authors describe the way they provide functional intervention by including iconic signs and words that give children “control of the environment” and “combine imitation of meaningful syllables with functional activities and referents”.

Goal setting was included in the program discussion. The goals are systematically laid out by the program based on the client level. The manual discusses the need for parent, family and client input for finding words and phrases that will be functional and motivating for the child as well.

The intrinsic feedback principle was discussed in the manual. The program emphasizes the need to encourage self-monitoring and presents a five-step hierarchy for teaching self-monitoring in chapter five. The steps range from total clinician monitoring to complete self-evaluation by the child without any clinician cues. The FMPA program is the only tool that directly discusses this principle in any depth.

Some components of extrinsic feedback were included in the program directions. Throughout the manual clinicians are encouraged to use knowledge of results (KR) feedback for children during treatment. The authors made one mention of using knowledge of

performance (KP) when providing feedback for clients. There was no discussion of delaying feedback. Although not directly addressed, the five step self monitoring hierarchy does use the principle of fading feedback.

Principles not utilized

No mention, instruction, integration or use of the cognitive motor learning principles of attention, instructions, distributed practice schedules, novice modeling, or delayed and summarized feedback was noted.

Discussion

Three published treatment tools designed for use with children diagnosed with childhood apraxia of speech and children demonstrating difficulties in the motor planning aspect of speech production were analyzed. The tools were examined for their utilization of cognitive motor learning principles. Overall, the findings suggested that the tools did use some cognitive motor learning principles as part of their programs. However, the tools generally did not directly instruct the clinician in strategic use of many of the principles and many principles were not significantly part of the design or in the clinical instructions. Many of the principles were minimally mentioned in the program manuals or not discussed or utilized at all. The principles of cuing and modeling were most emphasized by all three tools and based on the same literature from the Touch-Cue (Bashir, Grahamjones & Bostwick, 1984) and PROMPT (Chumpelik, 1984) systems. Further discussion of their use of cuing and expert modeling will be provided in a later paragraph. A comparison between the products revealed many similarities, and some differences as well.

Similarities

The three treatment tools shared many similarities in design and materials. No direct discussion of cognitive motor learning research was found in any of the manuals. Each of the programs did include some brief discussion of research background. However, direct citations were minimally included within the treatment recommendations and instruction sections. Each did include a bibliography section with some of the same articles and authors listed, including Yoss & Darley (1974a), Chumpelik's PROMPT system (1984), and the Bashir, Grahamjones & Bostwick's article on the Touch-Cue method (1984). The MAS program listed the fewest with only seven references, while the other two listed more than forty each. Rosenbek, Crary, Helfrich-Miller, Hall and Robin were other respected researchers in the areas of CAS diagnosis and motor speech treatment from the speech

language pathology field included in the references of the three programs. The exception was the FMPA program, which contained the most in depth exploration of the therapies for CAS and the research behind them. Minor to no inclusion of well-known cognitive motor learning research was found in the references of the programs.

Along with each mentioning the research basis of their programs to varying degrees all three explain that the programs were also created based on two or more authors collective clinical experiences. As the authors of MAS program say, “moving across syllables developed as an outgrowth of clinician experience with young children with developmental apraxia” (p. 2) The FMPA authors explain, “this approach was created out of the realization that therapeutic programs that rely heavily on a nonsense syllable approach frequently do not lend themselves to the rapid development of functional communication skills in children” (p. 1).

The cognitive motor learning principles that were used by all three of the treatment tools at varying levels were blocked and random practice, expert modeling, cuing, motivation, and extrinsic feedback.

Each of the programs provided comprehensive word lists with reproducible black and white illustrated picture drawings. The lists were organized based on place of articulation, syllable length and some consideration of manner of articulation. The lists were organized from lower to higher complexity. As discussed in the results section all three programs created similar word lists. The picture word cards were specifically designed to be used in blocked and random practice sessions. The design layouts of all the program materials lend themselves to utilizing the research supported principles from the cognitive motor learning field (although not directly acknowledged in any of the programs). For example, all three programs have a category of CVC (consonant, vowel, consonant) words that target bilabial sounds for initial and final sounds (e.g. Mom, map, beep). Each tool also made available reproducible forms for use in the evaluation and treatment delivery process.

As mentioned previously the use of cuing and expert modeling (no use of novice modeling was

noted) were the cognitive motor learning principles most strongly emphasized in all three of the treatment manuals, and recommended to be included in all three of the treatment programs. Each of the instruction manuals contained extensive descriptions of the strategic use of cues and expert modeling. All of the programs provide suggestions influenced by the PROMPT and Touch-Cue cuing methods. The MAS was the most in depth in its description of a cuing system. A chapter was dedicated to instructing clinicians how to specifically use the cuing system. The cuing was divided into three categories, visual, tactile and auditory. The procedures follow the cognitive motor learning principles of consistent modeling and cuing with a fading of cues as the learner gains mastery over the task eventually use intermittent cues or no cuing as needed. The FMPA program also strongly encourages the use of cuing with what they call "a multimodality approach" much like the MAS program, and give instructions in the strategic use of these principles. The EDI program provided the smallest section on cuing and modeling that emphasizes visual hand signaling to be combined with the auditory presentation of the speech sounds.

Unlike the principles of cuing and expert modeling the strategic use of feedback was not found to be utilized or instructed with regularity in any of the programs. Although it could be argued the cuing systems do provide a form of extrinsic feedback, the issue of the how and when of providing feedback about the results or performance of the child were minimally discussed in the treatment tools. A discussion or recommendations in the use of the principle of intrinsic feedback was also minimally included in the programs.

Differences

The MAS program offers a non-standardized screening test to help with the evaluation process and to assist in the selection of targets. The test score sheet allows for the tester to score the level of cuing along with a place to transcribe the productions of the client. A worksheet to analyze the sequencing of syllables during the test was also provided. The sheet allowed the scores from a pre and

posttest to be compared. The MAS program also offered the most involved discussion of selecting treatment goals. The goal selection process recommended by the program reflected the cognitive motor learning research. The inclusion of a section dedicated to generalization activities and "branching" strategies was different from the other programs as well.

The EDI program differed from the others with an overall sports theme and specific directions in the activities included in the program. The manual offered the most direct mention of the cognitive motor learning principles in recommendations, however very little rationale or explanation for their use was offered. The EDI program offered the most extensive list of references of the three programs.

The FMPA program differs with an emphasis on parental involvement in the evaluation and treatment process. Discussions of what parents would like to know and how to be helpful as a clinician was covered in depth. Although the FMPA program does not address the most of the cognitive motor learning principles, the principles that were included the program offered the most descriptive and substantial in use.

What Is Missing? The Bottom Line

The analysis process provided a clear picture of which cognitive motor learning principles were included and what level of principle involvement was offered by each treatment tool. The principles that were significantly part of the three programs included, blocked and random practice opportunities, and cuing and expert modeling system. Goal setting was moderately addressed. The principles that were minimally addressed in the therapy materials provided included, variable and distributed practice schedules, multiple practice experiences, novice modeling, instructions, attention, motivation, intrinsic and extrinsic feedback.

As has been discussed previously, SLPs often use the cognitive motor learning principles even when not consciously planned or directly included in treatment design. A strategic plan that supports use of the principles of cognitive motor learning has the potential to support a more effective and

efficient treatment delivery. Use of treatment tools that support conscious design and tracking of client and clinician behaviors during treatment sessions is highly advantageous. Any tool that can utilize strong research and easily support flexible clinical service delivery is desirable.

Development Of Overlay

Based on the findings of the analysis, two worksheets were created to be used during treatment to help maximize use of the cognitive motor learning principles discussed throughout this project missing from the analyzed treatment tools. An example of a complete program using some of the materials from all three tools plus the overlay developed to address the remaining principles not addressed by the reviewed programs is represented in table 4 (see appendix). This prototype of a treatment program was developed to show a possible way to design treatment program that directly use the principles of cognitive motor learning. The treatment programs that were analyzed for this project offer most of the materials and activity ideas that a clinician would need to get started. The overlays were developed to help remind a clinician to monitor the many components that contribute to effective and efficient therapy for motor speech disorders using the principles of cognitive motor learning. Clearly the skills and knowledge of the clinician delivering the treatment contributes greatly to the quality. The tools are of no use if the person does not know how to use them. A clinician using the overlay would need to be familiar with the cognitive motor learning principles prior to using the worksheets in order to be able to deliver service that utilized them. Table 4 was created to show the components of the prototype treatment program and their sources and is shown on following page.

Table 4

Principle	**Therapy Tool Components**	**Source of Component**
Blocked	Reproducible word lists/picture cards Practice & Performance tracking sheet	**MAS, FMPA, EDI** **Project**
Random	Reproducible word lists/picture cards Practice & Performance tracking sheet	**MAS, FMPA, EDI** **Project**
Variable	Reproducible word lists/picture cards Practice & Performance tracking sheet	**MAS, FMPA, EDI** **Project**
Distributed	Practice & Performance tracking sheet	**Project**
Experience	Practice & Performance tracking sheet	**Project**
Modeling		
Novice	Practice & Performance tracking sheet	**Project**
Expert	Practice & Performance tracking sheet Cuing System	**Project** **MAS, FMPA, EDI**
Cuing	Performance Tracking Sheet Cuing System	**Project** **MAS, FMPA, EDI**
Instructions	Program Development Worksheet	**Project**
Attention	Program Development Worksheet	**Project**
Motivation	Program Development Worksheet	**Project**
Goal Setting	Program Development Worksheet Behavioral objective worksheet Non-standardized Test Consonant & Vowel Inventory sheets	**Project** **MAS** **MAS** **EDI**
Intrinsic Feedback	Program Development Worksheet	**Project**
Extrinsic Feedback		
Knowledge of results (KR)	Practice & Performance Tracking sheet	**Project**
Knowledge of performance (KP)	Practice & Performance Tracking sheet	**Project**
Delayed	Practice & Performance Tracking sheet	**Project**
Faded	Practice & Performance Tracking sheet	**Project**
Summarized	Practice & Performance Tracking Sheet	**Project**

Two worksheets were created to be used during treatment planning and delivery. The Program Development Worksheet (see Table 5) was designed to help clinicians utilize the cognitive motor learning principles of goal setting and intrinsic feedback. This worksheet was created to help in the process of encouraging the client to be moving toward self monitoring and creating the desired motor

movements independently. The Practice & Performance Tracking Sheet (see Table 6) was designed to assist clinicians in monitoring use of the principles of instructions, attention, motivation, blocked, random variable and distributed practice schedules, experience, modeling (novice and expert), cuing, and extrinsic feedback (KP, KR, delayed, faded, and summarized). The tracking sheet was created to allow for individualized treatment and encourage strategic treatment design. A discussion of how these worksheets were created and the possibilities they may offer in assisting in clinical treatment will follow.

Program Development Worksheet

The Program Development worksheet was designed to help a clinician utilize some of the cognitive motor learning principles from the very start of the treatment program. As Strand (1995) says about devising a treatment approach for a client, "The clinician has to make a series of clinical decisions based on interpretation of assessment information and judgments about the relative contributions of cognitive, linguistic, motor planning and execution processes" (p. 131). Designing a treatment program is as much an art as a science because every individual is different. The more thorough a treatment program is the better, however flexibility must be present, so that it can be individualized. As stated earlier the Program Development Worksheet was designed to assist a clinician from the beginning to use the cognitive motor learning principles of motivation, goal setting and intrinsic feedback in the treatment program. The worksheet was designed to be used after the initial evaluation process has been completed and clinician and client are creating a treatment program. Based on the assessment results, target sounds, complexity levels, long term and short term goals are chosen. For example the EDI program offers vowel and consonant inventory sheets, or the MAS program non-standardized test could be used to identify targets. The worksheet allows for the input of the client, parents and caregivers to be recorded as the program is developed. A second page was created to track parent or caregiver feedback, and home practice program and results. As emphasized in the FMPA program, parent or caregiver participation and education are key components of most effective therapy.

The importance of frequent and sufficient practice in the cognitive motor learning principles can be addressed by clients participating in a home program to support treatment sessions with a SLP. A home program also provides variables to keep practice conditions unpredictable and supportive of true learning of new skills. As discussed in early sections, the cognitive motor learning research suggests that the more an individual is actively engaged with the process of learning a new skill the more actual learning takes place (Lee, Swinnen & Serries, 1994). The worksheet design seeks to encourage client participation and responsibility from the start of the process since the ultimate goal of any treatment program is an intrinsic feedback system that helps the client generalize the new skills into all environments while self monitoring. Table 5 contains the Program Development worksheet and is found on the following pages.

Table 5
Program Development Worksheet

Client: Start Date:

Evaluation Results	Goals and Objectives Long Term	Date %	Date %	Date met
Review consonant and vowel, syllable shape inventory etc.				
Targets	**Short Term** **#1**			
	#2			
	#3			
	#4			

Client Motivators:

VIPs (very important people):

VIWs (very important words):

Parent/Caregiver Comments:

Home Program Tracking

Dates & Prac.Time	*Who?*	*What?*	*How did it go?*

The Practice & Performance Tracking Sheet

When considering the use of the principles of instructions, attention, motivation, blocked, random variable and distributed practice schedules, experience, modeling (novice and expert), cuing, and extrinsic feedback (KP, KR, delayed, faded, and summarized) a clinician can become quite overwhelmed. All of these principles are somewhat automatic in any treatment interaction; however, remembering how and when to use them following the research finding of cognitive motor learning can test even the most seasoned clinician. The tracking sheet was created to allow for dynamic individualized treatment, encourage strategic treatment design, allow a clinician to track progress, monitor clinician responses to client behaviors and a home program. The sheet lists each of the principles to be monitored, tracked and adjusted during treatment on the right side. There is space for the targeted speech behavior and the day and time to be recorded. Boxes are also provided for comments to record information and performance details during the treatment. A chart summarizing the principles is listed at the bottom of the worksheet as any easy reminder during treatment sessions. As mentioned previously a clinician would have to be familiar and comfortable with the principles of cognitive motor learning to be able to use the worksheet most effectively. Table 6 contains the Practice & Performance Tracking worksheet and is found on the following pages.

See attached file table 6

DATE/Minutes of session		**Comments**
Goal/Target Behaviors		
PRACTICE *Instructions* clear, concise and descriptive		
Blocked *same target repeated*		
Random different targets unpredictable		
Variable same target different situations		
Modeling expert=E, novice=N		
Cuing Auditory=A, Visual=V, Touch=T		
Extrinsic Feedback Knowledge of results =KR Knowledge of performance=KP Delayed=D Faded=F Summarized=S		
Comments **CONDITIONS** **Environment** where is client practicing?		**Comments**
Intrinsic Feedback client self-monitoring		
Experience approx. how many productions		
Attention client focused and attentive to targets		

Motivation client aware of reason for target and engaged in productions		
Home Program		

Principle	Description	
Blocked practice	Deliberate and systematic use of repeated production of a target speech sound movement (e.g. same target in isolation until able to produce consistently).	
Random practice	Deliberate and systematic production of several targets in an unpredictable order.	
Variable practice	Adaptations of a same general motor program (e.g., /t/ is different words and positions).	
Distributed practice schedule	The learner attends shorter more frequent sessions	
Experience	Sufficient practice trials must be performed for motor learning to occur.	
Goal setting	Goals designed with client input so that they are working toward goals the learner wishes to achieve	
Extrinsic feedback	Knowledge of results **(KR)** feedback that gives the learner information about the accuracy of a production (e.g. *yes, that was correct*). Knowledge of performance **(KP)** gives the learner information about a performance (e.g. *yes, that time your tongue was behind your front teeth*). Presentation of feedback that is **delayed** by several seconds, **summarized** at optimal intervals, and the relative frequency is **faded** over time.	

Principle	Description
Modeling	A person providing an example that presents the timing or patterns of a skill that can be observed by the learner through visual and/or auditory means. (With an **expert** model the learner receives a precise representation of the target. A **novice** model provides an opportunity for the learner to benefit from the feedback the model is receiving and engages the learner in the problem solving process.).
Cuing	Techniques that direct the attention of the learner to key components of the modeled motor skill.
Instructions	Effective instruction is succinct and relevant to the learner. (The instructions should be brief, contain only one or two key points, and finer details should build on elementary information presented at the beginning.)
Attention	Target materials that do not remove the client's attention away from the targeted speech productions (this is a broad subject area, so the specific aspect listed was the focus of this analysis).
Motivation	Treatment designed so that client perceives the tasks included in activities during clinic as contributing to the ultimate goal of more intelligible and functional speech.
Intrinsic feedback	The ultimate goal of the cognitive motor learning approach is for learners to be able to learn a target task at a level where they can monitor themselves.

Possibilities

The challenging and developing investigation into the most effective and efficient treatment for CAS and related disorders has just begun. The cognitive motor learning research offers solid findings over many different fields and over time. The initial findings of researchers and clinicians in the speech and hearing sciences suggest that continued integration and experimentation is warranted. It is clear from the practices of many clinicians and the design of many treatment programs that the principles of

cognitive motor learning are already of part of the process. It seems logical that clinicians become more conscious and strategic in their use. Effective treatment assists clients in true learning of motor tasks, instead of performance in a clinical setting that does not generalize into the “real world”. Certainly much more research will be needed in the SLP field before more definitive findings into the specifics of motor speech production are revealed. However, there is strong evidence today for the utilization of these powerful principles already contributing to better learning for all sorts of people, from football players, to injured workers receiving physical therapy. As Robin (1992) says, “treatment programs should be based on the development of motor skills and, as such, adhere closely to the principles of motor learning” (p. 21). There is great deal of support for use of the cognitive motor learning principles in the speech language pathology field. Possibilities for treatment that employs these compelling tools provide both inspiration and a challenge for clinicians.

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