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The Influence Of Gestural Learning On Oral Reading And Reading Comprehension

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THE INFLUENCE OF GESTURAL LEARNING ON ORAL READING AND READING COMPREHENSION

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CHAPTER 1: Introduction

Training of visual-verbal associations by speech-language pathologists may be used to address difficulties in a variety of language tasks, including reading, naming, and receptive vocabulary. There is some evidence that visual-verbal associations may be facilitated by multi-modal cueing, but the general and specific benefits of multi-modal cueing treatment approaches have not been examined adequately. For example, it is not clear whether multi-modal cues such as gesture provide an advantage over verbal cueing alone, or which type of multi-modal cues may be more effective than others in visual-verbal learning. Studies of language learning in healthy volunteers can provide speech-language pathologists with clues to effective methods for language intervention in individuals with language difficulties. These include children with developmental reading delays or impairments, and adults with acquired dyslexia. The purpose of this project is to evaluate how gestural training may facilitate oral reading and reading comprehension of single words.

Motor learning has been found to facilitate visual processing in healthy children and adults (e.g., James & Atwood, 2009), and gestural training may promote verbal production in adults with aphasia (e.g., Rose, Douglas, & Matyas, 2002). Actively interacting with objects appears to change how the objects are perceived visually (e.g., James, 2010), and active writing of letter shapes has been found to promote visual perception of letters (Longcamp, et al., 2005). Motor training may be one bridge for promoting language and literacy across languages and cultures, because associations between actions and objects, including letters, are often common across languages and cultures.

In the current study, the effects of gesture training on learning of visual-verbal associations were examined in healthy, literate adults in a task of reading single words presented in novel script (i.e., pseudowords). Patterns of reading were compared across four training conditions to examine how gesture production may influence oral reading and reading comprehension.

CHAPTER 2: Review of the Literature

The following literature review is focused on multi-modal methods of language therapy that have been implemented or studied across different populations including children with language delay, children who learn English as a second language, and adults who have impaired communication as a result of a neurologic disruption. Multi-modal cognitive processing is described in the context of current theoretical models of comprehension and production of single words and sentences.

Multi-Modal Methods for Training Language in Children

Multi-modal cues are an integral part of many different approaches to language training in children. Among the approaches used by speech language pathologists are symbolic play, contextualized language treatment activities, and the targeted use of music and/or actions in language learning tasks. Naturalistic modeling of language by caregivers in everyday contexts includes multi-modality cues (Weiner, Lerner, &Easterbrooks, 2012) and results in children retaining information about both what their caregivers are saying and how they are conveying it. However, multiple cues often are combined in caregiver modeling of language and in many treatment tasks used by speech-language pathologists. More study is needed of the effects of each individual type of cue on language learning.

The typical method for a child to learn language and literacy is through the rehearsal of the spoken word and association of the auditory phonemes with the written graphemes; this leads to the child's competence in phonological awareness. The U.S. Department of Education (What Works Clearinghouse, 2012) defined phonological awareness training as, "any practice targeting young children's phonological awareness abilities" (p. 1). In a report about early childhood education interventions, they concluded, that phonological awareness training had potentially positive impacts on language and/or communication proficiencies for children with learning handicaps in early education contexts (U.S Department of Education, 2012).

Auditory discrimination skills including phonemic and phonological awareness are the primary components that are involved in the general education of learning the sounds of language, according to Hansen and Milligan (2012). Studies have demonstrated that the phonological awareness process is effectively acquired in children using two methods: learning to associate the printed form of words with the pronunciation of words in their spoken lexicon and discriminating the homophonic nonword foil from the correct spelling of the word (Duff & Hulme, 2012). Children learn language through repetition and rehearsal of spoken and written words, but studies have shown that this is not always the most effective method for learning language (e.g. Hurwitz et al., 1975; Kelley, 1981).

Hansen and Milligan (2012) noted that auditory and aural skills are necessary for a child to be successful in reading. They observed that “music is an aural/auditory art,” in which parents and educators teach children to follow the pitch changes and respond to musical stimuli (p. 75-76). Part of the phonemic and phonological awareness process is internalizing and discriminating sounds; this creates a foundation for a child to later, learn literacy and be communicative in a school setting (Hansen & Milligan, 2012). The most common method of teaching children phonological awareness skills demonstrated by English-speaking parents is input of spoken words that the child internalizes to create an output that has greater richness and complexity as he/she has made generalizations beyond the original input (Weiner, Lerner, & Easterbrooks, 2012, p. 179); this then aids children in the process of matching phonemes to graphemes through repeated exposure of sounds and words. Other cultures have demonstrated different forms of literacy and language acquisition. For example, learning through the sharing of stories is a main instructional approach in educating American Indian/Alaskan Native children (Inglebret, Jones, & Pavel, 2008); similarly, it has been observed that many African American children have demonstrated rich narrative skills (St. Clair & Phipps, 2008, 92). Research has shown that each of these methods have varying effects on language learning, but have been shown to be effective for helping children to establish a foundation of sounds and letters, thus preparing them for school (Hansen & Milligan, 2012).

Miller and Schwanenflugel (2006) demonstrated that there was a link between reading ability and prosody, an element of music. Specific to prosody were the following features: pauses in speech that reflected phrase and clause length, commas, exclamation/question marks, and periods; changes in pitch level that indicated the type of sentence, whether it was a command or question; specific stress on syllables, sounds or words that indicated the meaning; and a change in the rate of speech that indicated personal speaking styles and the mood of the speaker. Each of these abilities represented a significant part of understanding the sounds of language for children. Through the normal process of caregivers and educators teaching children literacy and language, they can also implement the use of prosodic/expressive reading as an instructional emphasis in the classroom. For example, Miller and Schwanenflugel (2006) established that teachers could observe the children using excessive or delayed pausing while they read as an indicator that they are limited in their abilities to decode the text. Through that same observation method, appropriate pitch contours could indicate that the children are proficient in their reading skills and are able to progress to more difficult texts and advanced topics.

Several researchers have reported that music interventions positively affected reading skills (Hurwitz et al., 1975; Kelley, 1981; Standley, 2008). In a review of several studies that focused on music in the learning process, Standley (2008) found that many researchers had similar theories about how children are ready at a young age to learn through multisensory instruction. Each of the studies incorporated music in several different ways and several of them based their intervention ideas on Orff, Kodály, or Dalcroze instruction, "which stressed multisensory, group activities adapted to the developmental abilities of the child and emphasizes active music making such as singing, rhythm instrument playing, or gesture to music" (Standley, 2008, p. 17). Hurwitz and colleagues (1975) found that first grade children who used the Kodaly Music Program, as compared to a group of children who did not, had improved performance during reading tests. Another researcher implemented the Orff music instruction with first grade children and compared results to children randomly assigned to a visual arts and a control group (Kelley, 1981). She found that music treatment effectiveness was not due to a growth spurt, but had a positive impact on reading performance and concept development. Overall, musical intervention, as compared to the control and visual coding group, demonstrated improvement in cooperation, self-concept, attentional skills, and manipulation of sound/strategy development.

Ritter, Colson, and Park (2012) completed a similar study but instead of implementing the use of music to aid in learning language and reading skills, they added an Interactive Metronome (IM) (as cited in Ritter, Colson, & Park, 2012) to correlate with the participants hand and foot movements. The metronome beats were generated by a computer that the children were instructed to listen to through a set of headphones. Then they were asked to match clapping or tapping motions (e.g. alternating toe taps, heel taps, clapping both hands together) while using the hand or foot trigger. Instant, real-time auditory feedback measured response timing and rhythm to the nearest millisecond. While only the research group was receiving the IM treatments, both the control group and research group were placed in language and reading intervention sessions. Both groups improved in reading fluency and reading comprehension, but the IM group outperformed the control group when comparing the results of pre- and post-standardized testing. While these results do have clinical value, it is unclear if the only cause for greater improvement in the research group was the IM treatment alone or if there were other factors involved.

Not all of the treatment methods created by researchers included one of the above listed musical instructions; instead they added musical activities to basic reading approaches. These musical activities included associating singing, performing, reading, discussing, and listening to previously established classroom curriculum for vocabulary and reading. Fisher (2001) assigned eighty students, who spoke Spanish at home, to one of four classrooms where two of the classrooms used music often and the remaining two did not. The music in two of the classrooms consisted of singing songs at the beginning of class that focused on self-esteem, listening stations to aid the children when spelling, and musical movement activities that related to texts that were read in class. These children and their teachers remained together in these classroom settings for two years, for kindergarten and first grade, and during that time several of the teachers sang the text of words used in the classroom and focused on sound-symbol relationships. The results of this study demonstrated that the incorporation of music with classroom-based learning had a positive effect on reading scores and oral language (Fisher, 2001).

When analyzing these studies that incorporated music as part of the learning process for language and literacy, Standley (2008) observed that some of the treatment sessions also had a positive impact on social skills such as listening and turn-taking. Therefore, the combination of music and education not only can benefit a child's reading and vocabulary, but also can improve the child's pragmatic skills. Music integration may help to facilitate children's confidence and social skills in a supportive environment where children can interact with their peers.

Early assessment and intervention of language have been found to be pertinent to the growth and education of ESL children. Kieffer and Vukovic (2012) examined, "the development of reading, language, and working memory skills between Grade 1 and Grade 4 for [ESL] learners and their native English-speaking peers from similarly low-income backgrounds" (Kieffer & Vukovic, 2012, p. 1165). One implication of the study found that ESL students, as a whole, demonstrated comprehension when referring to phonological awareness skills, but indicated weaknesses in the areas of oral comprehension and vocabulary that was consistent from Grade 1 to Grade 4. However, a small selection of the ESL children who had difficulty with word reading further demonstrated weaknesses in phonological awareness, working memory, vocabulary, and oral comprehension. These results indicated that increased prevention of reading difficulties is necessary in culturally and linguistically diverse populations; strategies can be implemented through the improvement of literacy instruction (Kieffer & Vukovic, 2012).

Calderón, Hertz-Lazarowitz, and Slavin (2013) evaluated the effects of Bilingual Cooperative Integrated Reading and Composition (BCIRC), a cooperate learning program, on English and Spanish writing, reading, and language achievement of limited English proficient children in second and third grade in Spanish bilingual programs. The BCIRC approach was adapted from the Cooperative Integrated Reading and Composition (CIRC) and consisted of three principle elements: integrated language arts and writing, direct instruction in reading comprehension, and "treasure hunt" activities (Stevens, Madden, Slavin, & Farnish, 1987). The treasure hunts were worksheets that incorporated many parts of language learning including story retell, vocabulary activities, comprehension questions, and story-related writing prompts. The authors found that the CIRC program had positive effects on standardized test measures including spelling, language expression, reading comprehension, and vocabulary. The students who participated in CIRC also demonstrated improved performance in oral reading and writing (Stevens, Madden, Slavin, & Farnish, 1987).

Calderón and colleagues (2013) chose to adapt the CIRC model because it was highly interactive and structured to aid bilingual teachers in managing their English, Spanish, and transitional literacy activities proficiently. Their incorporation of five different factors helped bilingual Spanish speaking children transition from Spanish reading and vocabulary skills to understanding of English reading and vocabulary skills. These five areas of focus included: 1) comprehensive teacher development where they became partners and researchers in all adaptation phrases; 2) incorporation of primary language acquisition theories, philosophies, and practices; 3) incorporation of second language (primarily Spanish) developmental theories, philosophies, techniques, and strategies; 4) incorporation of the best methods and techniques for facilitating students to make the transition from Spanish reading and writing abilities to English; and 5) adoption of student-centered philosophy that encourages self-confidence and teacher sanction. This method of helping ESL students was effective in producing improved reading and language achievement based on standardized language expression measures and standardized achievement results that measured the students' oral reading skills.

One possible method of helping CLD children succeed in the English school system is the implementation of the program "Sounds in Motion" (Santore, 2006). This program introduces phonemes to kindergarteners and first graders by using the concept of whole body listening with focus on auditory discrimination, specifically of consonant sounds that are often misarticulated. Whole-body listening, as described by Truesdale (1990), is a way of teaching children to listen and learn by using their brains to think about what the speaker is saying; listening with both their eyes and ears; quitting movement of their hands, feet, and mouth; and sitting tall to better focus on the speaker. Santore (2006) stated, "Through the use of body movements, the characteristics of tension, duration, pitch, and directionality of the articulators that are associated with each speech sound are introduced to help the children experience correct placement and production for specific consonants (para. 6)." Not only does the approach incorporate listening skills, but also adds the components of reading and writing the syllables and the words introduced through movement. This program has been practiced with children who have difficulty with developing oral language and early writing and reading skills; this parallels with the learning weaknesses of CLD children and as a result the "Sounds in Motion" approach may be an effective learning method of learning sounds across a variety of groups.

Three other programs were also reviewed to investigate the learning of phonemes as they are related to gestures: "Lively Letters" (Telian & Castagnozzi, 2001), "Bringing Words to Life" (Beck, McKeown, & Kucan, 2002), and "Jolly Phonics" (Vinden, Rowsell, Wernham, & Lloyd, 1987). "Lively Letters" focuses on training letter sounds, phonics skills, and phonemic awareness. These tasks are implemented through activities that use stories, picture cards, hand prompts, music, and oral kinesthetics to aid the children in recalling their letter sounds (Telian & Castagnozzi, 2001). "Bringing Words to Life" is more focused on developing children's vocabulary through given information about words and stimulation in an enhanced language and literacy environment (Beck, McKeown, & Kucan, 2002). Finally, "Jolly Phonics" (Vinden, Rowsell, Wernham, & Lloyd, 1987) focuses training on phonics and grammar while incorporating music, books, computer software, videos, and coloring books. The target of the program involves multi-sensory integration to learn the different letter sounds including the use of occasional arm and hand movements that are correlated with the specific sounds. While these programs are increasing language and literacy learning in children, they do not address the idea of combining movements and/or gestures with sounds and words, dissimilar from the "Sounds in Motion" program previously reviewed (Santore, 2006).

Kohnert, Yim, Nett, Kan, and Duran (2005) addressed issues with planning and implementing effective programs for CLD children. They found that support of the home language development, by educators and SLPs, was important for the child's cognitive, social, emotional, and communication skills. Through thorough examination of other studies, Kohnert and colleagues (2005) found evidence that maintenance of the child's home language does not hinder the comprehension and use of a second language. They noted "…it appears that systematic support for the home language through the preschool years ultimately increases academic achievement and proficiency in the majority language…" (Kohnert et al., 2005, p.254). To achieve this goal of academic achievement, Kohnert and colleagues (2005) suggest training paraprofessionals and parents and implement the use of peer modeling to aid CLD children in developing language and communication skills. The training for paraprofessionals and parents involves more than just handouts and brief descriptions of techniques; this approach more effectively trains them to focus on the incorporation of multiple instructional methods and specific language facilitation strategies. The suggested use of peer modeling by these authors included pairing CLD children who speak the same home language while incorporating direct monitoring and arrangement of an environment for interaction (Kohnert et al., 2005).

A method of language intervention that already incorporates gestures with language learning is symbolic play. This treatment approach typically is implemented with infants and preschool age children who speak English as a primary language. This is an effective form of language acquisition training as it allows the child to experience both receptive and expressive language through participation in play experiences (Roth & Worthington, 2011). Themes and activities that are suggested for facilitating play include: pretending to act out simple every day single actions such as sleeping and eating; manipulating a toy animal to act out familiar activities such as eating and drinking; and pretending to act out familiar sequences such as making food, putting it on a plate, and eating it. Symbolic play incorporates movements and gestures as part of these functional activities, which can facilitate language learning in young ESL children learning English because the symbolic play is recognized across different languages and cultures. Finally, research has found that symbolic play is the most important natural context for early language development and the early acquisition of social communication skills (Norris & Hoffman, 1990). Norris and Hoffman (1990) explain that, "The communications that the child produces are expanded and refined to be more specific and conventional, growing toward adult knowledge and understanding of the linguistic code" (p. 72).

Contextualized therapy is an approach to intervention that is similar to both symbolic play and rehabilitation therapy applied to patients who have suffered from a traumatic brain injury (TBI). Ylvisaker, Szekeres, and Feeney (2008) have completed extensive research on the subject of treatment in TBI patients; their findings have demonstrated that the most effective form of treatment is one that occurs in a real-life context that creates the opportunity for functional communication for that client. The goal of clinicians who treat TBI clients in functional settings is to help to generalize the learned behaviors to everyday situations outside of clinic. Presumably, this contextualized therapy also can help to create effective maintenance programs as the client is immediately practicing and working in an environment that is both positive and encouraging in terms of functional communication.

This contextualized therapy technique has also been applied to children in a classroom setting with the goal of increasing social skills. Wiener and Harris (1997) applied context-sensitive, routine-based, everyday approach to an intervention for special education classes in the form of a social skills training program. This program "used a combination of coaching and social problem-solving approaches…to develop and evaluate a sample of 45 children, 9 to 12 years old, with learning disabilities" (Wiener & Harris, 1997, p. 40). The results of the observations collected from the teachers and peers during classroom, recess, and lunch activities demonstrated that the children made gains in social skills and there was a reduction in the occurrence of problem behaviors.

Effects of Motor Cueing on Language Learning

Language treatments that incorporate actions may affect brain organization. According to Wakefield, James and James (2013), "researchers have demonstrated that interacting with objects can change how objects are later perceived, substantiating the idea that active learning affects cognitive processing—our brains process objects differently after a history of active exploration" (p. 58). For example, James (2010) found that learning-by-doing helped to strengthen the neuronal circuits in children's brains, indicating that the sensori-motor experience has an effect on the visual system and therefore can establish a base for later visual letter recognition. In another study, it was found that when an individual performs actions, it activates the visual cortices without simultaneous visual provocation; "therefore in the developing brain, associations are built upon real-world interactions of body and environment, leading to sensori-motor representations of both objects and words" (James & Swain, 2011, p. 673). Finally, a third study demonstrated that an individual's motor system is activated during the presentation of visual objects, signifying that the person's motor system is implicated in the method of visual processing at some stage (James & Atwood, 2009).

There is evidence that motor learning could play a role in the manifestation of neural specialization for letters (James & Atwood, 2009). James and Atwood (2009) proposed a detailed relationship among motor and perceptual systems during pseudoletter perception. The results of this study may have implications for everyday letter perception. Noting that sensorimotor integration plays a significant role when an individual is writing letters (James & Gauthier, 2006), James and Atwood proposed that, "Sensorimotor experience in the form of learning to print and write letters allows the interplay between motor production and visual perception to broaden the stored representation of letters" (2009, p. 93). They concluded that the motor construction of word forms may lead to motor procedures that correlate with and are assembled with learned visual experiences.

Gestural training is another form of motor cueing that has been incorporated into language learning paradigms. Porch (1967) reported that gestures have been used as form of communication for patients with aphasia because gestures are often spared compared to verbal communication abilities (as cited in Bandur & Shewan, 2008). One study found that among seven participants with aphasia and limb apraxia, each one was able to either "supplement their verbal communication with a lexical gesture or completely substitute gesture for verbalization" (Rose & Douglas, 2003, p.461). This demonstrated that individuals with language limitations may benefit from language instruction and communication that includes signs and gestures. Bandur and Shewan (2008) also stated that gestures can be used to cue or facilitate verbal language in an individual with aphasia as it provides a greater descriptive value to the verbal output modality.

Kroenke, Mueller, Friederici, and Obrig (2012) studied the effects of gestures on inherent recall of newly acquired words. The study was completed with novel words paired to root words that were trained across five different conditions presented to healthy adults. These included examining word pairs without any gesture, word pairs with meaningless grooming gesture, or word pairs with meaningful iconic gesture. The second question observed the role of self-involvement by implementing gestures that were either actively repeated or passively viewed by participants (Kroenke et al., 2012). To aid in analysis of the results, the research team applied the use of an fMRI to view the activations of different networks when responding. The results of the imaging demonstrated that "the recall of [novel word] forms for fully established lexico-semantic items seems to be quite robust across different learning strategies in healthy adults" (Kroenke et al., 2012, p. 14). Therefore, their research supported the idea that speech production was interactive with gestures at the conceptual level; various neural networks were activated depending upon the learning strategy that was applied (Kroenke et al., 2012). While the results of the study suggested that, behaviorally, gesturing did not necessarily improve lexico-semantic learning, it should be noted that the researchers collected data from the whole group and did not observe individual differences. Kroenke et al. (2012) also observed the learning of word pairs over a three-day period. The first day they observed differences among the tasks: the grooming (meaningless) gestures were recalled worse than those learned without any gesture or iconic (meaningful) gestures, whereas the third day there was no advantage for any of the tasks. These results suggest that the participants had time to adjust to the various learning conditions and improve their strategy for learning.

Language and literacy intervention strategies that pair spoken action words with gestures may help to increase the rate of language learning for children in schools who have not received optimal exposure of the language in their homes (Bialystok & Feng, 2009). Arbib (2005) found, through studies of neural and functional grounding of language skills, that there is a close relation between spoken words and gesture processing; these findings demonstrated that treatments that pair gestures and language could be effective in improving naming impairments. Another study paired arm and hand gestures, including pointing, visualization, and cue articulation, with picture naming to improve word production deficits at the level of phonological access and encoding (Rose, Douglas, & Matyas, 2002). Rose and colleagues found that the use of iconic (i.e., meaningful) gestures significantly improved picture naming skills as the gestures acted as a facilitator for word production. The effectiveness of this treatment is based on pairing phonological rehearsal with gestures that are associated with the word, increasing language comprehension.

A Theoretical Model of Multi-Modal Input to Word Learning

Visual, auditory, gestural and other forms of sensory information are generally believed to activate a common semantic system that supports comprehension through these various input modalities (e.g., Raymer & Rothi, 2008). The theoretical model depicted in Figure 1 includes perception and recognition of the perceived input as a familiar spoken form, object/picture, gesture or written word. This information then activates semantic memory for comprehension of meaning. For expression, this semantic information activates memories of abstract word forms or action knowledge that will be used for gesturing, writing, or verbal production. This abstract information is held temporarily in working memory during activation of peripheral processes for motor programming and motor movement.

As depicted in Figure 2.1, printed stimuli that are not familiar and have no meaning (e.g., FLIG) can be converted from print to sound via a nonlexical conversion process. The model depicts a similar conversion process for imitation of meaningless gestures. Viewed gestures that are meaningless can be converted to action via a nonlexical gesture conversion process. In contrast, viewed gestures that are meaningful can be recognized as familiar, comprehended within semantic memory, and then stored action knowledge within the Action Output Lexicon can be accessed for production of a meaningful gesture. Figure 2.1 does not show additional input modes (e.g., tactile) and output modalities (e.g., drawing) for communication, but these are assumed to function similarly in healthy adults and in children who are developing their memory stores for these language functions.

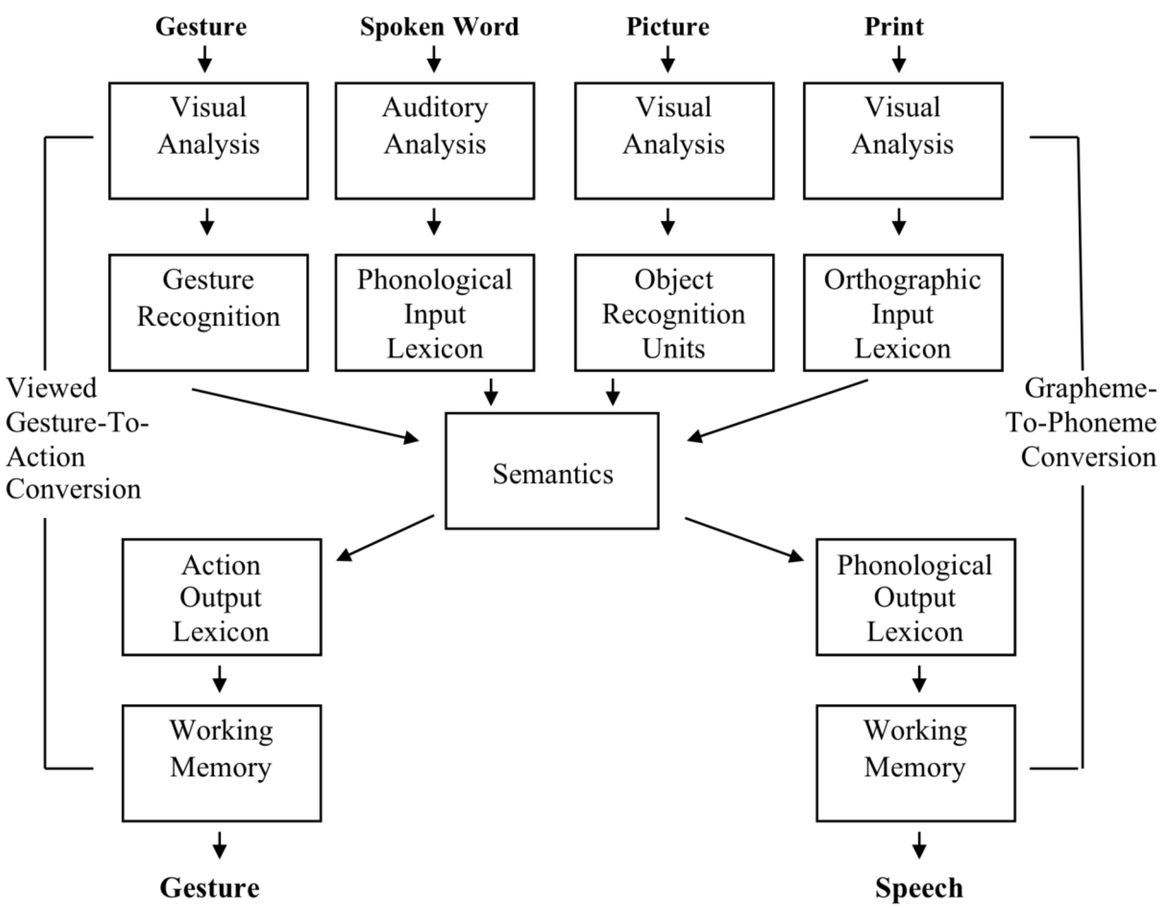

Figure 2.1 A Theoretical Model of Single Word Processing (based on Raymer & Rothi, 2008)

The acquisition of reading skills is often described as involving two different reading routes (e.g., Bandur and Shewan, 2008). By the first route of letter-to-sound conversion, labeled Grapheme-to-Phoneme Conversion (GPC) in Figure 2.1, written words are broken down into individual graphemes (e.g., L or PH) and each grapheme converted to a phoneme. The phonemes are then blended to create a word, either spoken or kept in working memory. Overreliance on this sublexical route of reading can result in mispronunciation of irregularly spelled words. The second route that a child can use to read is labeled the Lexical-Semantic or “whole-word” reading route. When using this route, the child will read a written word and comprehend it through recognizing the whole word form, comprehending its meaning, and retrieving the whole word phonological form for its pronunciation. Both reading routes are very useful for children learning to read. The whole-word route supports reading of familiar words; therefore there is previously stored knowledge relating to those sounds in the words being read. The GPC route is still effective when reading because if a child comes upon a word they do not know, then they can use this route to sound out the word and then add another word in his/her lexical-semantic oral reading route. For spelling, a dual-route model can also be described in which phonemes are converted to grapheme (PGC route) or whole words are accessed via a lexical-semantic spelling route.

A child who is delayed in language may be using only one of these routes, limiting his/her ability to learn how to read and comprehend language. Acquired disorders of reading and/or spelling in persons with aphasia may reflect differential impairment to one of these reading or spelling routes with sparing of the alternative route (e.g., Arguin & Bub, 1994; Silverberg, Vigliocco, Insaluco, & Garrett, 1998). For example: if the child is reading using the GPC route only, then he has to parse each word into individual letters, associate phonemes with each of the graphemes, and then blend them together to read the word. This process can take a lot of time and is more taxing on the individual mentally as compared to using the lexical-semantic route where previously learned information can be applied and the word does not need to be broken down each time it is read. If the child is hearing a spoken word, he may only use the PGC route to break down the phonemes into graphemes and as a result may mispronounce or misspell the word because of overreliance on one route compared to the other.

Davies, Rodríguez-Ferreriro, Suárez, and Cuetos (2012), examined "the factors that influence reading aloud in typically developing and dyslexic readers in a transparent orthography, Spanish" (p. 734). Transparent orthography is a written language where graphemes have a one-to-one relationship with phonemes as compared to an opaque orthography like English where the relationship is less direct and graphemes can be matched to a multiple number of phonemes. While analyzing reaction time and response duration, the authors found that phonological coding errors can occur in the either lexical or sub-lexical routes, or both. The sub-lexical reading route function was reflected in the participants when reading aloud words that differed in length (4-5 letters verse 7-8 letters). The lexical route was reflected in the frequency of words presented. The data from this study demonstrated that the lexicality effect in combination with the frequency effect was impacted by the lexical knowledge on reading in transparent orthography (Davies et al., 2012). Therefore, children are capable of reading aloud through the use of both the lexical and sub-lexical coding and decoding processes in a transparent orthography (Davies et al., 2012).

In assessing language function in adults and children, the speech-language pathologist characterizes areas of strength as well as areas of deficit. As depicted in Figure 2.1, auditory verbal language function is closely related to other forms of language such as written language and gesture. As shown, gestural output and verbal output are thought to stem from a common semantic system and input to the semantic system derives from gestural, visual and other input sensation. In applying this theoretical modal as a framework for treatments to impairments of single-word production, intervention can be applied to the combination of multiple output modalities.

Action Knowledge in Sentence Processing

The role of action knowledge in speech production has been represented in cognitive-linguistic models of sentence processing by various types of verbs and their relationships to other sentence elements. One theoretical model by Garrett (cited in Mitchum & Berndt, 2008) is characterized by five levels of normal sentence production, the first three of which are: 1) Message Level, 2) Functional Level, and 3) Positional Level. The message level is preverbal and represents the listener's appreciation of the event that is occurring; i.e. a person understands something is happening and wants to communicate it to others. At the functional level, the concept of something happening is represented linguistically including lexical selection or meaning of the words and determining the thematic structures of those words; the thematic roles of "who does what to whom" is assigned to specific words in the sentence. That information is then sent to the positional level where the phonological information is retrieved and, separately, the grammatical frame the words need to be placed into to form a correct sentence; this level also includes prosodic and segmental features to the word structure.

Sentence comprehension shares many of the same components that Garrett (as cited in Mitchum & Berndt, 2008) labels in his theory of normal sentence production. The message and functional levels are involved in both sentence production and comprehension, as demonstrated in studies of lexical access concluded by Levelt, Roelofs, and Meyer (1999). At the positional level, segmental and prosodic contours of the sentence are first interpreted followed by parsing the sentence to identify phrasal frames to organize the lexical and grammatical content of the sentence. Specific phonological word-forms of lexical content are also identified here. Then the separate word forms are transferred to the functional level where lexical information is identified semantically and inferred thematically; this permits the listener to understand the central action and logical roles of those elements that are involved in the action. This decoding process allows the listener to understand the intended message. Finally, the separate roles, sounds, and words are transferred to the conceptual level (message level in normal sentence production) where the event is understood as a whole. This model is helpful in understanding how people produce and comprehend information and allows the listener and/or speaker to be aware that a lot of activity is occurring at each level; as a result, when there is limited language comprehension, it can be difficult to understand where the source of the problem lies.

The improved understanding of how spoken sounds and words are decomposed and formulated in sentence production and comprehension can aid the SLP in making clinical decisions about how to teach language and literacy to children. Whether they are bilingual or monolingual, children are able to comprehend several components of language at a rapid rate; knowing the components of normal verb and sentence processing can aid the SLP in developing model-based approaches to language intervention.

Mitchum, Haendiges, and Berndt (1993) completed a study that focused on verb retrieval as a specific type treatment for sentence production where the source of impairment was in verb word forms in sentence production in two individuals with chronic aphasia. The researchers found that that although the patients did improve their ability to retrieve specific lexical verbs, neither one was able to apply the newly learned verbs to sentences. These results suggested that traditional naming therapies, specifically ones that target picture naming, are limited in their effectiveness beyond the single-word level; improved verb retrieval typically fails to improve sentence production. Fink, Schwartz, and Myers (1998) trained participants to focus on the thematic and grammatical elements in written sentences by having them choose the theme, verb, and subject in response to specific query questions. Cues and prompts were used as the intervention strategy in the form of corrective feedback. Even though this treatment process demonstrated positive results, especially for production of sentences, there was evidence that the difficulty of the training task limited the success in certain conditions for some participants. The authors concluded that the demands of the task overwhelmed the participants and demonstrated results that did not generalize to comprehension of other verbs and sentence types. Both of these findings, in relation to the stimulation of action words through picture naming, revealed that simple naming of verbs alone is not effective in improving sentence production in patients with aphasia.

Raymer and Ellsworth (2002) focused on the semantic, phonologic, and rehearsal of verbs to improve one client's mild verb retrieval impairment. Accuracy was judged for trained and untrained verbs; the results demonstrated that there was improved naming for trained verbs, some generalization of learned verbs to sentence production, and no improved retrieval for untrained verbs. Even though the study focused on semantic and phonological treatment processes as well as rehearsal, there was no difference in the effects of verb learning across treatments.

Both of these treatments previously summarized were effective in training verb retrieval at the word level, but the learned behavior did not transfer to the sentence level. As a result these methods of intervention were not functional as the clients did not gain comprehension of applying meaning, thematic and grammatical frames, and lexical content to the words as a whole. In comparison, other methods to improve verb retrieval focus on the whole sentence and the incorporation of actions. Marshall (as cited in Mitchum & Berndt, 2008) encouraged one client to use both imagery and gesture while she was attempting to state the sentence. For example, the client was instructed to imagine the dog at her feet and the dog on a leash. At the same time, the client was also instructed to complete the actions that would indicate these events were occurring; therefore she would look down at her feet and hold her hand out like she was holding a leash. After the imagery and actions were in place, the client attempted to state a sentence about the created situation. In this way, minimal demands were placed on the impaired language system and instead gestures were used to navigate around this level of sentence comprehension. The client broke down the verb-relevant information to form simple phrases, focusing on the linguistically applicable elements of each event.

Summary

The above review of the literature highlights ongoing efforts to determine the best methods for children to learn language and literacy skills. Multi-modality cues are often used in a variety of treatment approaches but their relative effectiveness of one cue is seldom assessed in the absence of the other cues. For example, several of these programs implemented music in conjunction with gesture or movements; therefore it can be difficult to know if it is the music or the movement or both that was aiding the children in learning language. Also, a few of these reports did not have adequate detail about how the experiment was completed or scored, making the results difficult to interpret.

However, taken together, these studies of contextualized language intervention and sentence processing highlight the potential effectiveness of multi-modal approaches to teaching language and literacy skills. Children who have had limited access to spoken English language and written words (i.e. books) often begin school in the U.S. with a disadvantage compared to their monolingual English age-matched peers. The use of gestures/actions to train vocabulary and reading skills may be particularly relevant for this group of children as they have limited exposure to English, but have been introduced to gestures and movement since they were born. The influence of gesture on language learning may depend on the type of gesture, type of language task, type of training paradigm used, and individual differences.

Levels of gestural language include the sentence level, single word level and single letter level. One could gesture to convey the meaning of a sentence, including the action and the thematic roles (i.e., who is doing what to whom). At the single word level, one could gesture to convey the meaning of a single whole word (e.g., eating). Also, one could gesture to convey the meaning of a single letter (e.g., T). The benefits of gesture training on verbal language learning may vary depending on the level of gestural language trained (sentence, word, or letter levels). At the single word level, gesture training may facilitate lexical reading more than nonlexical reading (GPC). However, a visual gesture cue at the letter level may support lexical and nonlexical reading equally. Meaningless gestures may actually detract from word learning due to their incongruity with word meanings and their attentional demands.

Research Questions and Hypotheses

There is a lack of research specifying how gesture training may facilitate language and literacy in culturally diverse children and in individuals with language impairment or delay. Further research into the differential effects of gestural or verbal training on language learning will contribute to intervention efforts as well as to the development of cognitive models of how action and verbal knowledge interact in healthy literate adults. In the current study, we addressed the following research questions:

Research Question 1: How is accuracy of oral reading of novel script in healthy adults influenced by training with verbal cues alone, verbal cues plus meaningful word-level gestures, verbal cues plus visual tracing gestures, or verbal cues plus meaningless gestures? Null Hypothesis: There are no significant differences in accuracy of oral reading of novel script trained under the four training conditions.

Research Question 2: How is reaction time or oral reading of novel script in healthy adults influenced by training with verbal cues alone, verbal cues plus meaningful word-level gestures, verbal cues plus visual tracing gestures, or verbal cues plus meaningless gestures? Null Hypothesis: There are no significant differences in reaction time of oral reading of novel script trained under the four training conditions.

Research Question 3: How is accuracy in reading comprehension of novel script in healthy adults influenced by training with verbal cues alone, verbal cues plus meaningful word-level gestures, verbal cues plus visual tracing gestures, or verbal cues plus meaningless gestures? Null Hypothesis: There are no significant differences in accuracy in reading comprehension of novel script trained under the four training conditions.

Research Question 4: How is reaction time in reading comprehension of novel script in healthy adults influenced by training with verbal cues alone, verbal cues plus meaningful word-level gestures, verbal cues plus visual tracing gestures, or verbal cues plus meaningless gestures? Null Hypothesis: There are no significant differences in reaction time in reading comprehension of novel script trained under the four training conditions.

CHAPTER 3: Methods

Participants

Thirty-two healthy, literate adults (17 male and 15 female) participated in the study. All participants were monolingual English speakers. Their age ranged from 19-60 years with a mean age of 24 (SD=9.4); years of education ranged from 13-18 with a mean of 14. No participants had a history of developmental learning difficulties, history of injury or disease affecting the central nervous system, alcohol or drug abuse, current multiple medical problems or extreme fatigue. All participants passed screenings of hearing, vision, and reading ability.

Before enrollment in this study, each participant gave informed consent. Privacy and confidentiality were maintained as required by the WSU Human Investigation Committee.

Screening Measures

The hearing screening consisted of an informal test of speech discrimination in which the examiner verbal presented single words to each participant. The stimuli in this screening were 25 monosyllabic words consisting of phonemes ranging from the lowest to the highest in speech sound frequency (Causey, Hood, Hermanson & Bowling, 1984). The examiner read each word to the participant at normal speaking volume while the examiner's mouth was covered to block visual cues. The participant was asked to repeat each word after the examiner.

The vision screening consisted of a spoken word to picture matching task. The examiner read aloud 10 words and the participant was asked to point to the corresponding picture from an array of 4 black and white line drawings.

Each participant's reading ability was screened using the Wide Range Achievement Test-Revised (WRAT-R; Wilkinson, 1993). This also served as an additional screening of vision. The reading subtest of the WRAT-R includes words ranging in difficulty according to grade level. The participant read the words starting at the easiest word and continued until he or she could no longer accurately pronounce the words written.

Each participant was asked to report information about their educational and medical history so that those aspects related to the exclusionary criteria could be ruled out. For example, exclusionary criteria included a history of developmental learning difficulties, or an injury or disease that affected the central nervous system.

General Procedures

All screening measures and experimental measures were administered in one session of approximately 70 minutes. The same examiner assessed each participant individually in a quiet room. The instructions for each task were presented to each participant using a standard script (see Appendix A). If the participant did not appear to understand the instructions, they were repeated once or twice. All training and assessment items were presented on a laptop computer using a standard protocol across participants, as described in detail below. Each participant's responses during the experimental measures were audio-recorded using a Sony Digital Voice Recorder for scoring of accuracy and reaction time. At the end of the session, each participant was asked about any learning strategies they may have used to complete the experimental tasks, and their perceptions of the training and assessment items.

Experimental Measures and Stimuli

Five experimental tasks were administered including four oral reading tasks and one cumulative comprehension task. Each task is described in turn below.

Oral Reading Task 1: Verbal training alone. Given novel script, the participant was trained to imitate the English equivalent word (n=15).

Oral Reading Task 2: Verbal plus meaningful gesture training. Given novel script, the participant was trained to imitate a meaningful word-level gesture and the associated English word (n=15).

Oral Reading Task 3: Verbal plus meaningless gesture training. Given novel script, the participant was trained to imitate an incongruent, meaningless gesture and to imitate an English word (n=15).

Oral Reading Task 4: Verbal plus letter-level tracing gesture training. Given novel script, the participant was trained to imitate a visual tracing gesture and to imitate an English word (n=15).

Delayed Comprehension Task: Each trained word (n=60) was presented in a yes/no verification task. This involved simultaneous visual presentations of the novel script with the trained English word in written form. The participant was asked to indicate 'yes' if the novel script matched the written word and to indicate 'no' if the novel script did not match the written word. Distracter items were semantically related, phonologically related or unrelated to each target. An item was credited as correct only if it was accepted when presented with its correct written name and also rejected when presented with the incorrect written name.

Pseudoletters to make up the novel script stimuli were created using Microsoft Word symbols. The script was contained to a minimum of one and a maximum of two symbols in length. The stimuli did not include symbols that were physically similar to English graphemes. One of the novel script stimuli was a duplicate and therefore was excluded.

The English words trained as associates to the novel script were verbs selected based on frequency, regularity, and transparency of gesture. The frequency ratings were cumulative (including headings and titles) and were based on Francis and Kucera (1982). Mean frequency was matched across the four word lists to be trained in the four conditions. The four word lists were also balanced for visual similarity, phonological similarity, semantic category, length and type of gesture (transitive or intransitive; one-handed or two-handed).

All training and assessment measures were presented using Microsoft PowerPoint on a 2007 IBM laptop computer with Windows Vista basic programming. Each slide presented had a white background and black Calibri font centered on the slide.

During the four training conditions in the study, the participants viewed standard instructions to “Say the word aloud” (for the verbal cue only condition), or to “Say the word aloud and imitate the movement” (for the verbal cue plus gesture conditions). Training in all four conditions was accomplished by presenting a video embedded into each PowerPoint slide and positioned on the slide above the novel script item being trained. Each practice video was 4.5 inches high and 6 inches wide. In training with the verbal cue alone, the video showed a white wall and the participant heard the verbal stimulus cue three times. For the three training conditions involving gesture cues (i.e., a meaningful gesture, a visual tracing gesture, or a meaningless gesture), the video showed a person modeling a gesture three times while simultaneously saying the associated English word aloud three times. The person in the video was pictured from the waist to the neck and wearing a black sweater as a backdrop to the gestures. For all four training conditions, participants imitated each model immediately, producing the response just after the model or simultaneous with the model. The length of the model video was 7-8 seconds and every training slide was set to switch to the next practice item after a standard 10 seconds. The time interval between the conclusion of one slide and the presentation of the next slide was approximately .5 seconds. Between each training condition, there was a 3-minute break.

During each training condition, periodic testing of oral reading was preceded by the written prompt, "Now just say the word associated with the nonsense symbols." This testing of oral reading was accomplished using novel script presented for 4.5 seconds. The time interval between the conclusion of one slide and the presentation of the next slide was approximately .5 seconds. At the end of each training condition, all 15 items trained were presented for oral reading. During this testing of 15 items, each slide was presented for 4.5 seconds with an interval between items of approximately .5 seconds. The onset of each stimulus was time tagged using an auditory tone for later calculation of reaction time.

In the cumulative comprehension task, the 120 experimental stimuli were presented in a random order determined by an online randomization program (Urbaniak & Plous, 2014). Three instruction slides were included for a total of 123 slides. Each slide was presented for 4.5 seconds, with a time interval between the conclusion of one slide and the presentation of the next slide of approximately .5 seconds. Stimulus slides were presented continually within Block 1 (n=60), followed by a 2-minute break, followed by Block 2 (n=60). On each stimulus slide, the novel script was presented below a capitalized English word, e.g., "Is this PLAYING?" Task instructions for the comprehension task were as follows: "Say aloud 'yes' or 'no' to indicate if the written word matches the symbols presented. It will keep going every 5 seconds. Do not worry if you forget; instead continue with the test. If you are not sure, just guess."

Generative naming was used as a distracter task and administered after the fourth training task and before the delayed comprehension task. The total time between the fourth task and the delayed comprehension task ranged between three and four minutes, depending on each participants understanding of the new directions (e.g. some of the participants required the directions to be repeated). In the generative naming task, the participants were asked to say as many words in a given category as they could in one minute. First, the participants were asked to name words that started with the letter "s," and they were next asked to name animals. Participants' scores were within the normal range.

Order of Training and Assessment Activities

The 32 participants were randomly assigned to one of four orders of administration of training tasks, so that eight participants received each of the four task orders. The four different task orders were used in an attempt to control for the effects of practice and fatigue. The four training tasks always preceded the distracter task, and the distracter task and the delayed comprehension task were given in the same order to all participants (see Table 3.1).

Table 3.1 Sample Order of Task Presentation
1: Verbal Cue Alone (3 practice items then 15 stimuli trained)
2: Verbal + Visual Tracing Cue Task (3 practice items then 15 stimuli trained)
3: Verbal + Meaningful Gesture Task (3 practice items then 15 stimuli trained)
4: Verbal + Meaningless Gesture Task (3 practice items then 15 stimuli trained)
5: Distracter task: Generative Naming
6: Delayed Comprehension: Verification task

Each of the four training conditions began with three practice items to familiarize the participant with the task. Then the 15 target items were trained in sets of three, with intermittent testing of retention (see Figure 3.1). There was a final test of retention of all 15 items immediately following the last trained item. The total time for each training task was 8 minutes and 18 seconds.

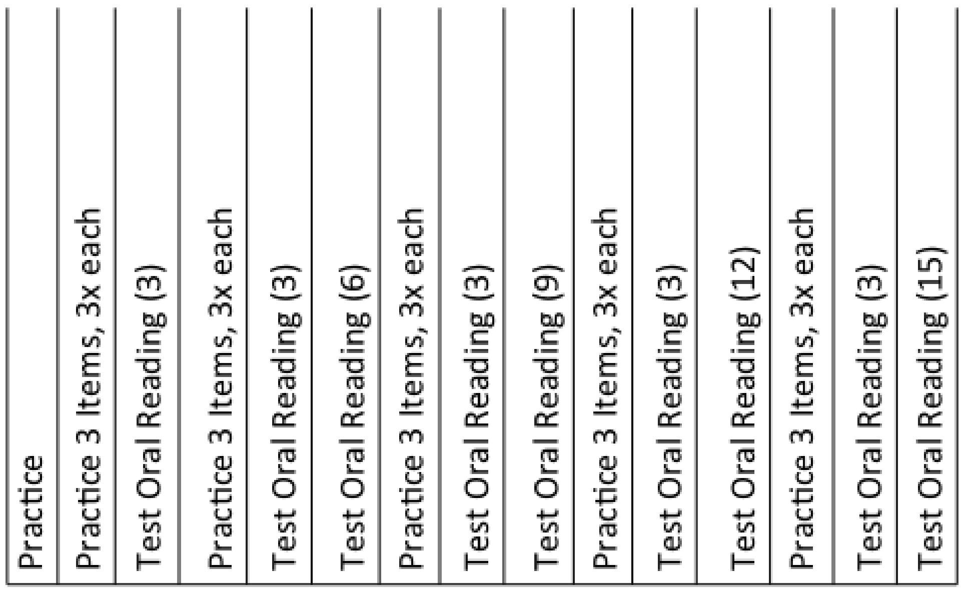

Figure 3.1 Timeline of Practice and Testing in Each Training Condition

As shown in Figure 3.1, after each new set of three items was practiced, the new set was tested and then all of the items practiced up to that point were tested in random order. This training paradigm was chosen because it allowed the influence of test frequency on performance to be compared to the influence of practice alone.

Scoring

For each training task, each participant's naming responses in assessment portions of the task were scored for accuracy. Performance in the final test of naming (n-15) in each training task was scored for accuracy and error type using predetermined error classifications and scoring criteria. Error types of the symbol based stimuli, such as similarities among presented novel script, were scored as follows: 1) Semantic-related errors including coordinate, subordinate, superordinate, associate, and description or definition (e.g. incorrect response "full" for presented word "eat"); 2) Phonological errors if the error contained >50% of the target phonemes; the first sound of each word was also observed and recorded when similar; 3) Visual errors if they contained >50% of the target symbol and the same first symbol was also noted; 4)

Unrelated errors; 5) Perseverative errors; and 6) Other errors. Error types were also observed based on the gesture stimuli and these were scored as follows: 1) Semantic; 2) Visual errors if the gesture contained >50% of the target gesture; 3) Other; 4) Perseverative; and 5) Unrelated. For the meaningless gesture condition, the raters referred to the stimulus videos if needed to resolve all scoring questions. The visual stimuli were also referred to throughout the scoring process as needed.

For each of the four training conditions, each participant's responses in the final test of naming (n=15) also were scored for reaction time. Reaction time was measured for correct responses only. The participants' recordings of their responses were used to measure reaction time from the onset of each stimulus to the onset of the participant's verbal response. The program used to record reaction time was an iPhone application "P Stopwatch" (CaziSoft, LLC, 2012).

The delayed comprehension task was scored using two separate methods. In the first method, responses to each of the 120 stimuli individually were scored as correct (correctly accepted or rejected the match) or incorrect (incorrectly accepted or rejected the match). In the second method, performance for the 120 stimuli was evaluated for each pair of stimuli such that each trained item (n=60) was only scored as correct if it was both correctly accepted when presented with the correct match and also correctly rejected when presented with the incorrect match. This second method was the basis for comparisons of performance across the four training conditions, as described in the Results section. Statistical analyses for all tasks were completed using IBM SPSS Statistics (Version 22).

CHAPTER 4: Results

This study addressed approaches to training print to sound associations in healthy adults. The effects of four training conditions were compared in immediate recall and in a delayed comprehension task. The data obtained were assessed with respect to the following comparisons: 1) differences in oral reading accuracy across the four training conditions; 2) differences in oral reading reaction time across the four training conditions; 3) differences in comprehension accuracy across the four training conditions; and, 4) differences in comprehension reaction time across the four training conditions.

Comparisons of Oral Reading Accuracy Across Training Conditions

The first research question posed in Chapter Two addressed the accuracy of performance in immediate recall as measured by oral reading of words trained across four training conditions. It was predicted that participants would perform most accurately in orally reading novel script that was trained using meaningful gesture, followed by training with the visual tracing cue, then verbal training alone, and finally, verbal plus meaningless gesture.

Research Question 1: How is accuracy of oral reading of novel script in healthy adults influenced by training with verbal cues alone, verbal cues plus meaningful word-level gestures, verbal cues plus visual tracing gestures, or verbal cues plus meaningless gestures?

Null Hypothesis: There are no significant differences in accuracy of oral reading of novel script trained under the four training conditions.

The mean number of correct responses in oral reading was computed for the words studied in each of the four training conditions. See Table 4.1 for descriptive statistics. Accuracy scores represent performance in the final test phase of each training condition (n=15 items). To examine the effects of training condition on performance accuracy, a one-way analysis of variance (ANOVA) was conducted. The repeated measures factor Task included the four training conditions: Verbal Cue Alone versus Verbal Cue Plus Meaningful Gesture versus Verbal Cue Plus Tracing Gesture versus Verbal Cue Plus Meaningless Gesture.

Table 4.1

Results of One-Way Repeated Measures ANOVA: Oral Reading Accuracy by Condition

	Mean	SD	df	F	p
Verbal Alone	.563	.189	3,93	11.835	.000
Verbal + Meaningful Gesture	.362	.216			
Verbal + Tracing Gesture	.432	.201			
Verbal + Meaningless Gesture	.402	.235			

Table 4.1 shows the significant main effect for condition. The accuracy rates were significantly different across the four training conditions. Paired sample t-tests were performed to compare the performance of participants in each condition, with accuracy rate as the dependent variable. Performance in the Verbal Cue Alone condition was significantly more accurate than the Verbal Plus Meaningful Gesture condition ($t(31)=5.233$, $p=.000$), the Verbal Plus Visual Tracing Gesture condition ($t(31)=3.813$, $p=.001$), and the Verbal Plus Meaningless Gesture condition ($t(31)=4.881$, $p=.000$). Moreover, accuracy rates were significantly higher in the Verbal Plus Visual Tracing condition than in the Verbal Plus Meaningful Gesture condition ($t(31)=-2.25$, $p=.032$). There was no significant difference in accuracy between the Verbal Plus Meaningful Gesture condition and the Verbal Plus Meaningless Gesture condition ($t(31)=-.943$,

p=.353) or between the Verbal Plus Visual Tracing Gesture condition and the Verbal Plus Meaningless Gesture condition (t(31)=.881, p=.385).

Comparisons of Oral Reading Reaction Time Across Training Conditions

The second research question posed in Chapter Two addressed the reaction time in immediate recall as measured by oral reading of words trained across four training conditions. It was predicted that participants would perform fastest in orally reading novel script that was trained using meaningful gesture, followed by training with the visual tracing cue, then verbal training alone, and finally, verbal plus meaningless gesture.

Research Question 2: How is reaction time or oral reading of novel script in healthy adults influenced by training with verbal cues alone, verbal cues plus meaningful word-level gestures, verbal cues plus visual tracing gestures, or verbal cues plus meaningless gestures?

Null Hypothesis: There are no significant differences in reaction time of oral reading of novel script trained under the four training conditions.

The mean reaction time in oral reading was computed for the words studied in each of the four training conditions. See Table 4.2 for descriptive statistics. Reaction times represent performance in the final test phase of each training condition (n=15 items). Incorrect responses were excluded from calculation of reaction times. To examine the effects of training condition on performance accuracy, a one-way analysis of variance (ANOVA) was conducted. The repeated measures factor Task included the four training conditions: Verbal Cue Alone versus Verbal Cue Plus Meaningful Gesture versus Verbal Cue Plus Tracing Gesture versus Verbal Cue Plus Meaningless Gesture. A Log10 transform was used to normalize the reaction time data set.

Table 4.2

Results of One-Way Repeated Measures ANOVA: Oral Reading Reaction Time by Condition

	Mean	SD	df	F	p
Verbal Alone	.212	.102	3,84	1.690	.175
Verbal + Meaningful Gesture	.262	.126			
Verbal + Tracing Gesture	.257	.115			
Verbal + Meaningless Gesture	.225	.113			

Table 4.2 shows that there was no significant main effect for condition. Because the reaction times were not significantly different across the four training conditions, the data were not analyzed further.

Comparisons of Comprehension Accuracy Across Training Conditions

The third research question posed in Chapter Two addressed the accuracy of comprehension for words trained across four training conditions. It was predicted that participants would perform most accurately in recalling novel script that was trained using meaningful gesture, followed by training with the visual tracing cue, then verbal training alone, and finally, verbal plus meaningless gesture.

Research Question 3: How is accuracy in reading comprehension of novel script in healthy adults influenced by training with verbal cues alone, verbal cues plus meaningful word-level gestures, verbal cues plus visual tracing gestures, or verbal cues plus meaningless gestures?

Null Hypothesis: There are no significant differences in accuracy in reading comprehension of novel script trained under the four training conditions.

The mean number of correct responses in comprehension was computed for the words studied in each of the four training conditions. See Table 4.3 for descriptive statistics. An item was scored as accurate only if the participant correctly accepted the match when it was correct and also correctly rejected an incorrect match for that item when it was incorrect. To examine the effects of training condition on performance accuracy, a one-way analysis of variance (ANOVA) was conducted. The repeated measures factor Task included the four training conditions: Verbal Cue Alone versus Verbal Cue Plus Meaningful Gesture versus Verbal Cue Plus Tracing Gesture versus Verbal Cue Plus Meaningless Gesture.

Table 4.3

Results of One-Way Repeated Measures ANOVA: Comprehension Accuracy by Condition

	Mean	SD	df	F	p
Verbal Alone	.564	.234	3,93	4.057	.009
Verbal + Meaningful Gesture	.423	.194			
Verbal + Tracing Gesture	.511	.162			
Verbal + Meaningless Gesture	.494	.220			

Table 4.3 shows the significant main effect for condition. The accuracy rates were significantly different across the four training conditions. Paired sample t-tests were performed to compare the performance of participants in each condition, with accuracy rate as the dependent variable. Performance in the Verbal Cue Alone condition was significantly more accurate than the Verbal Plus Meaningful Gesture condition ($t(31)=3.331$, $p=.002$). Moreover, accuracy rates were significantly higher in the Verbal Plus Visual Tracing condition than in the Verbal Plus Meaningful Gesture condition ($t(31)=2.321$, $p=.027$). The difference between

accuracy in the Verbal Cue Alone condition and the Verbal Plus Meaningless Gesture ($t(31)=1.941$, $p=.061$) did not reach statistical significance. There were no significant differences in accuracy between the Verbal Plus Meaningful Gesture condition and the Verbal Plus Meaningless Gesture condition ($t(31)=-1.687$, $p=.102$), between the Verbal Cue Alone condition and the Verbal Cue Plus Visual Tracing Gesture condition ($t(31)=1.233$, $p=.227$) or between the Verbal Plus Visual Tracing Gesture condition and the Verbal Plus Meaningless Gesture condition ($t(31)=.402$, $p=.102$).

The amount of time between the completion of the fourth training condition and the start of the comprehension task did not affect accuracy in the comprehension task. Comprehension accuracy was 60% when this time delay was 3 minutes to 3 minutes and 20 seconds long, whereas comprehension was 59% accurate when this time delay was 3 minutes and 21 seconds to 3 minutes and 40 seconds long.

Comparisons of Comprehension Reaction Time Across Training Conditions

The fourth research question posed in Chapter Two addressed the reaction time of comprehension for words trained across four training conditions. It was predicted that participants would perform fastest in recalling novel script that was trained using meaningful gesture, followed by training with the visual tracing cue, then verbal training alone, and finally, verbal plus meaningless gesture.

Research Question 4: How is reaction time in reading comprehension of novel script in healthy adults influenced by training with verbal cues alone, verbal cues plus meaningful word-level gestures, verbal cues plus visual tracing gestures, or verbal cues plus meaningless gestures?

Null Hypothesis: There are no significant differences in reaction time in reading comprehension of novel script trained under the four training conditions.

Reaction times in comprehension were computed for the words studied in each of the four training conditions. See Table 4.4 for descriptive statistics. Reaction times were based on accurate responses only. An item was scored as accurate only if the participant correctly accepted the match when it was correct and also correctly rejected an incorrect match for that item when it was incorrect.

Table 4.4

Results of One-Way Repeated Measures ANOVA: Comprehension Reaction Time by Condition

	Mean	SD	df	F	p
Verbal Alone	1.944	.471	3,93	.068	.977
Verbal + Meaningful Gesture	1.982	.599			
Verbal + Tracing Gesture	1.970	.325			
Verbal + Meaningless Gesture	1.975	.493			

Table 4.4 shows that there was no significant main effect for condition. Because the reaction time rates were not significantly different across the four training conditions, the data were not analyzed further.

Comparisons of Performance by Order of Presentation

The order of item presentation had the potential to influence performance in the oral reading task, in that participants had more exposure to items presented earlier on the training list than items later on the list. As seen in Figure 2.1, each set of three items trained was tested more often than the subsequently trained sets of three. To evaluate the potential influence of more frequent testing on performance, we compared oral reading accuracy across each set of three items trained in the Verbal Cue only condition. Average performance in oral reading for items trained in the different sets of three was approximately the same.

Accuracy of oral reading was also reviewed according to the order of task presentation. As described in the Methods section, four different presentation orders were used such that eight participants received each of the four orders. As shown in Table 4.5, overall the total scores for accuracy in oral reading by order were similar. Because oral reading accuracy was tested immediately at the end of each training condition, these total numbers suggest that task order as a whole did not influence oral reading accuracy.

Table 4.5

Oral Reading Accuracy by Order of Task Presentation

	Presentation Order			
Tasks	1st	2nd	3rd	4th
Verbal Alone	50%	50%	58%	67%
Visual Cue	60%	42%	36%	36%
Meaningful	27%	60%	31%	28%
Meaningless	27%	25%	58%	41%
Total	41%	45%	46%	45%

Reaction time in oral reading was also reviewed according to the order of task presentation. As shown in Table 4.6, the total reaction times were longer for tasks presented first as compared to tasks presented later in the test sequence. This result may reflect initial adaptation to the experiment in that participants may have increased their speed with more practice in completing the experiment.

Table 4.6

Oral Reading Reaction Time by Order of Task Presentation

	Presentation Order			
Tasks	1st	2nd	3rd	4th
Verbal Alone	1.542	1.642	1.833	1.591

Visual Cue	1.828	1.553	2.218	1.778
Meaningful	2.182	1.772	1.462	2.042
Meaningless	1.914	1.991	1.492	1.446
Total	1.867	1.740	1.751	1.714

Accuracy in the delayed comprehension task was also reviewed according to the order of task presentation. As shown in Table 4.7, the practiced visual-verbal associations were better retained for the items that had been practiced more recently (4th in the task sequence) as compared to those tasks presented earlier. Although overall retention in the delayed task was poor, this result suggests that participants were putting forth a good effort in the delayed comprehension task.

Task 4.7

Comprehension Accuracy by Order of Task Presentation

	Presentation Order			
Tasks	1st	2nd	3rd	4th
Verbal Alone	45%	41%	63%	77%
Visual Cue	53%	48%	44%	59%
Meaningful	29%	53%	46%	41%
Meaningless	34%	22%	68%	57%
Total	40%	45%	55%	58%

Reaction time in the delayed comprehension task was evaluated according to the order of task presentation. As shown in Table 4.8, the total scores for reaction time were longer for tasks presented first as compared to tasks presented later in the test sequence. As with the oral reading reaction time data presented above, this result appears to reflect a practice effect.

Table 4.8

Comprehension Reaction Time by Order of Task Presentation

	Presentation Order			
Tasks	1st	2nd	3rd	4th
Verbal Alone	2.264	1.782	2.060	1.671

Visual Cue	2.115	1.940	1.978	1.943
Meaningful	1.991	1.917	2.096	1.924
Meaningless	1.976	2.238	1.830	1.857
Total	2.09	1.97	1.99	1.85

Accuracy scores were compared to the educational level of each participant. Performance was similar across participants and did not appear to be influenced by level of education. Age also did not appear to influence accuracy scores across participants.

Errors in Oral Reading

Oral reading errors were analyzed for stimuli trained in the verbal plus meaningful gesture condition. This condition yielded the largest number of errors of the four training conditions, including 'No Response' errors and 127 errors for which a verbal response was produced. Of these 127 verbal errors, 32% were unrelated to the target, and 48% were related visually to the target (i.e., 21% were visually similar to the target in that they shared at least 50% of target letters, 17% were visually similar and had the same first symbol, and 10% were both semantically related and visually similar). In addition, 9% of the 127 verbal errors were words that came from the same training set of 3 as the target word. The remaining errors only represented 1-3% of the error corpus and consisted of similar gesture, semantically related only, phonologically related, same first phoneme, perseverative, and a combination of same training set and semantically related. Thus, the most distracting or hindering agent in the learning process of novel script appeared to be visual similarity.

CHAPTER 5: Discussion

This study addressed two areas of interest: 1) the influence of gestural training on oral reading performance; and, 2) the influence of gestural training on reading comprehension. Visual-verbal associations were trained under four different conditions to evaluate the effects of training on immediate recall and delayed retention. Immediate recall was measured using an oral reading task, and delayed retention was measured using a verification task as a test of comprehension. Each of the four training conditions included verbal cues, but the verbal cue was presented either alone, with a meaningful gesture, with a visual tracing gesture, or with a meaningless gesture.

The Effect of Gestural Training on Oral Reading

The first two research questions posed in Chapter 2 addressed the issue of how gestural training may affect learning of visual-verbal associations for oral reading. It was assumed that meaningful gesture cues would facilitate learning more than the verbal cue alone, and that the visual tracing gesture cue would improve learning more than the verbal cue alone. It was predicted that training with the meaningless gesture would lead to reduced learning as compared to the other three training conditions.

Research Question 1: How is accuracy of oral reading of novel script in healthy adults influenced by training with verbal cues alone, verbal cues plus meaningful word-level gestures, verbal cues plus visual tracing gestures, or verbal cues plus meaningless gestures? Null Hypothesis: There are no significant differences in accuracy of oral reading of novel script trained under the four training conditions.

Research Question 2: How is reaction time or oral reading of novel script in healthy adults influenced by training with verbal cues alone, verbal cues plus meaningful word-level gestures, verbal cues plus visual tracing gestures, or verbal cues plus meaningless gestures? Null Hypothesis: There are no significant differences in reaction time of oral reading of novel script trained under the four training conditions.

The results of this study do not support the assumption that training with meaningful gestures facilitates learning of visual-verbal associations more than verbal training alone. Accuracy rates in oral reading of words learned in the Verbal Plus Meaningful Gesture condition were significantly reduced as compare to the Verbal Cue Alone condition. Also, the assumption that training with a visual tracing gesture would aid learning more than training with the verbal cue alone was not supported by this study. Training in the Verbal Cue Alone condition led to significantly higher accuracy in oral reading than did training in the Verbal Plus Visual Tracing Gesture condition. The assumption that training with meaningless gestures would interfere with learning compared to training with the verbal cue only was supported by this study. Training in the Verbal Plus Meaningless Gesture condition led to significantly lower accuracy in oral reading as compared to the Verbal Cue Alone condition. However, oral reading accuracy for words trained in the Verbal Plus Meaningless Gesture condition was not significantly different from accuracy in oral reading of words trained in the Verbal Plus Meaningful Gesture condition or the Verbal Plus Visual Tracing Gesture condition. Interestingly, training in the Verbal Plus Visual Tracing Gesture condition led to significantly higher accuracy in oral reading than training in the Verbal Plus Meaningful Gesture condition. Reaction times in oral reading were not significantly different for words trained in the four training conditions.

The unexpected finding that the Verbal Cue Alone training condition facilitated learning more than the other three training conditions has several possible explanations. It may reflect previous learning experiences of the adult participants. That is, the healthy adults in this study may have had more previous training in learning in a structured oral reading task by using verbal practice alone. Potentially this factor may have made it difficult for them to learn using gestures.

An alternative explanation for the differences in performance across tasks is that they reflect the attention demands of the different training conditions. This could apply to the input modalities involved, to the output modes, or to both. As for the input modalities, the Verbal Cue Alone condition involved only one visual stimulus (the novel script) and one auditory stimulus (the spoken word), whereas the other three training conditions included two visual stimuli (gesture and novel script) and one auditory stimulus (the spoken word). Possibly training with only one visual input modality in the Verbal Cue Alone condition was less demanding of attentional resources than the other conditions and thus was more effective as a means for learning visual-verbal associations.

Considering the output modes involved in the four training conditions, the Verbal Cue Alone condition involved only one output modality (verbal), whereas the other three training conditions include two output activities (verbal and gestural). The dividing of a participant's attention between two output activities may have impaired the learning process as compared to the verbal alone. This may have made it difficult to retain the meaning of the symbols in semantic memory for later recall. Although occasionally some of the participants would attempt to use the gesture to aid in word recall, this was inconsistent and often ineffective. Sometimes the participant produced a correct gesture but was still unable to produce the verbal name.

Improved accuracy in oral reading for words trained with a visual tracing gesture compared to a meaningful gesture may indicate that participants were focusing on the visual characteristics of the novel script in attempting to learn visual-verbal associations. The visual tracing may have been more effective than the meaningful and meaningless gesture training because the visual cue was a tracing of symbol shape as compared to the hand gestures applied in the meaningful and meaningless tasks. The visual cue may have aided in establishing the familiarity of the symbol and the transfer of the newly learned symbol to semantic memory. Within semantic memory, the visually based information can be associated with the heard word to establish its meaning. In the other two gesture conditions, the gesture did not emphasize symbol shape and, instead, provided a competing visual cue that was congruent with the heard word but that competed with the visual symbol presented. This may be why provision of the visual tracing cue was a more effective training approach than the other two gesture conditions.

Reduced accuracy of oral reading for words trained with meaningless gestures was an expected finding in this study. However, it was not expected that training with meaningless gestures would facilitate learning more than training with meaningful gestures. The overall result that verbal training alone led to higher accuracy than any of the gesture training conditions suggests that gestures can hinder association of verbal names with static visual symbols. If there is competition between two visual input modalities (gestures versus print), participants may choose to focus on the printed symbols and try to ignore the gesture during the training phase. Improved performance for words trained with the visual tracing gesture may reflect this strategy, as noted above. Accuracy of oral reading was significantly lower for words trained with meaningful gestures as compared to meaningless gestures. This unexpectedly poor performance for words trained with meaningful gestures could reflect increased demands on attentional resources during the meaningful gesture condition in that the gestures were recognizable and thus may have been harder to suppress than the meaningless gestures.

The Effect of Gestural Training on Reading Comprehension

Two of the research questions posed in Chapter 2 addressed the issue of how gestural training may affect retention of learning of visual-verbal associations in a comprehension task. It was assumed that meaningful gesture cues would facilitate learning more than the verbal cue alone, and that the visual tracing gesture cue would improve learning more than the verbal cue alone. It was predicted that training with the meaningless gesture would lead to reduced learning as compared to the other three training conditions.

Research Question 3: How is accuracy in reading comprehension of novel script in healthy adults influenced by training with verbal cues alone, verbal cues plus meaningful word-level gestures, verbal cues plus visual tracing gestures, or verbal cues plus meaningless gestures? Null Hypothesis: There are no significant differences in accuracy in reading comprehension of novel script trained under the four training conditions.

Research Question 4: How is reaction time in reading comprehension of novel script in healthy adults influenced by training with verbal cues alone, verbal cues plus meaningful word-level gestures, verbal cues plus visual tracing gestures, or verbal cues plus meaningless gestures? Null Hypothesis: There are no significant differences in reaction time in reading comprehension of novel script trained under the four training conditions.

The results of this study did not support the assumption that retention of learning as measured by the comprehension task would be improved for words trained with meaningful gestures as compared to those trained with verbal cues alone. Training with the verbal cue alone led to significantly higher accuracy in retention than training with the meaningful gesture or with the meaningless gesture. Training with the visual tracing gesture led to significantly higher accuracy than training with the meaningful gesture. Training with the meaningless gesture resulted in better retention than training with the meaningful gesture, although this difference was not statistically significant. Reaction times in comprehension were not significantly different for words trained in the four training conditions.

These accuracy results for the comprehension task parallel some of the findings for the oral reading task discussed above. As in the oral reading task, it appears that inclusion of gesture in training hindered learning of associations between printed symbols and verbal names as compared to training with the visual cue alone. The significant increase in comprehension accuracy for words trained with the visual tracing gesture as compared to those trained with the meaningful gesture suggests that the participants may have shifted attentional focus to the printed symbol during the learning phase. The visual tracing condition permitted the participants to trace the shape of the stimuli, matching the gesture to the exact shape of the stimuli. This method of learning may have been more effective than the gesture tasks as the movement more closely relates to the actual shape of the symbol. In contrast, the recognizable and meaningful gestures may have been difficult to suppress if the two visual input modalities were competing for attentional resources, thus causing reduced learning of the visual-verbal associations in the context of meaningful gestures.

Clinical Implications

The novel symbols used in this reading study were comparable to English letters in visual complexity. Thus, learning to attach a verbal name to the novel script was a similar task to learning to read English print aloud. (It should be noted that this similarity is to whole word reading but not to grapheme to phoneme conversion because only whole words were trained in the current study.) Clinical implications of the study results are in the areas of treatment of developmental reading in children, acquired dyslexia in adults, oral picture naming and receptive vocabulary for pictures. To the extent that learning patterns for auditory-verbal language are similar to visual-verbal language associations, these findings also have clinical implications for auditory-verbal language learning.

The results of the current study were different than those of some studies in the literature discussed above. For example, one study had found that the use of gestures paired with spoken words could increase the understanding of sounds and letters more effectively than spoken words alone (Rose, Douglas, & Matyas, 2002). These different outcomes may reflect the fact that participants in the current study were healthy volunteers whereas the participant studied by Rose and colleagues had mild conduction aphasia. Alternatively, these differences may reflect the time frame of the practice in that the current study involved short-term practice and retention within one session, as compared to the five one-hour sessions used in the study by Rose and colleagues. However, the current study results suggest that multi-modal training involving gestures may tax attentional resources and reduce learning of visual-verbal associations, at least in the short term.

Various patterns of impaired recognition, comprehension or pronunciation of written words emerge in children or adults with dyslexia. The results of the current study suggest that attempts to recognize and pronounce print may be facilitated through focus on the static print symbols and repetition of the associated verbal name. A gestural cue that involves tracing of the visual symbols (or letters) may interfere by causing distraction from the main task of associating viewed symbols to phonology. However, this distraction is not as severe as the distraction potentially caused by inclusion of a gesture that is not visually similar to the printed symbol. In contrast to the predicted outcomes in this study, multi-modal cueing involving a meaningful gesture did not facilitate oral reading or reading comprehension. One clinical implication of this finding is that children who are progressing normally in learning to read may perform best in acquiring a reading vocabulary for whole-words when they focus on the visual characteristics of print and practice the corresponding verbal name.

Still, for some children with developmental dyslexia and adults with acquired dyslexia, the provision of gesture cues (particularly the visual tracing gesture) may assist them if they have difficulty in activating phonological representations directly from print. Based on the performance on the participants in the current study, learning would be less effective using this multi-modal method than verbal practice alone but could ultimately lead to improvement in whole-word reading. An alternative treatment approach that would not involve verbal pronunciation could focus on reading comprehension by providing the child with a gesture to be matched to a picture or a written word. This intervention strategy would circumvent any problem in translating print to sound via the whole-word route or the GPC route. Instead, the treatment focus would be on building familiarity with the visual stimulus and associating it to semantic meaning that is also activated by the viewed gesture.

The initial unfamiliarity of a novel visual stimulus may be highly demanding of attentional resources when a person is learning to associate the visual stimulus to a spoken word in oral word reading or picture naming. However, as the print or picture becomes more familiar visually, the person may be able to incorporate other modalities of input during the learning process. Thus, when it comes to visual-verbal associations, learning via multi-modal treatment approaches may not facilitate learning in the initial stage, but afterward may be helpful in solidifying the meaning of the visual stimulus and its relationship to a functional language context. This understanding of oral reading and learning language can be applied to children who speak English as a second language, normally developing children, and children who have language, learning, and/or literacy delays.

As noted above in Chapter 2, the relative effects of each type of input cue or output response have not been examined sufficiently in studies of multi-modal language treatment. For example, although one may assume that treatment tasks that are enjoyable to children (e.g., active contextualized therapy) would result in greater gains in language learning than verbal practice alone, systematic study of these effects is needed. In particular, differential effects of learning of single words versus sentences and functional language contexts should be examined. Additional research should include a better distribution of ages and a larger participant group to gain a better understanding of how age affects language learning. It is possible that young children may be better able to attend to multi-modal input during language learning than were the adult participants in this study. Finally, future research is needed to examine individual differences in healthy volunteers and persons with language delay or disruption.

APPENDIX

Four Tasks Instructions:

"You will see nonsense symbols and hear a word that corresponds to the symbols. Memorize the word you hear as it matches the symbols. If a gesture is given, imitate the gesture in the air in front of you."

"There are 4 tasks total. They will keep going and you will be given a 3 minute break between each one. Do you have any questions or do you want any part of the directions repeated?"

Distracter Task Instructions:

"Now, I am going to have you name as many items as you can in a category for one minute. For example, I will say the name of a letter and then you will name all the words you can that start with that letter. But don't use people's names. Are you ready? ..... Okay, the first letter is 'S'."

"This time I am going to say a category that does not involve naming words that start with a certain letter, but instead a group of things. Tell me as many words as you can think of that are animals."

"Okay."

Final Comprehensive Task Instructions:

"You will now see each of the symbols that you practiced. Say aloud yes or no to indicate if the written word matches the symbols presented. It will keep going every 5 seconds. Do not worry if you forget; instead continue with the test. If you are not sure, just guess. Do you have any questions?"

REFERENCES

Arbib, M. A. (2005). From monkey-like action recognition to human language: An evolutionary framework for neurolinguistics. *Behavioral and Brain Sciences, 28*, 105-167.

Arguin, M., & Bub, D. (1994). Pure alexia: Attempted rehabilitation and its implications for interpretation of the deficit. *Brain and Language, 47*, 233-268.

Bandur, D. L. & Shewan, C. M. (2008). Language-Orientated treatment: A psycholinguistic approach to aphasia. In Chapey, R. (Ed.). *Language Interventions strategies in Aphasia and Related Neurogenic Communication Disorders* (pp.756-799). Baltimore, MD: Lippencott, Williams & Wilkins.

Beck, I. L., McKeown, M. G., & Kucan, L. (2002). *Bringing words to life: Robust vocabulary instruction.* New York: Guilford Press.

Bialystok, E. & Feng, X. (2009). Language proficiency and executive control in proactive interference: Evidence from monolinigual and bilingual children and adults. *Brain & Language, 109*(2/3), 93-100.

Calderón, M., Hertz-Lazarowitz, R., &Slavin, R. (1998). Effects of Bilingual Cooperative Integrated Reading and Composition on students making transition from Spanish to English reading. *The Elementary School Journal, 99*(2), 153-165.

Causey, G.D., Hood, L.J., Hermanson, C.L., & Bowling, L.S. (1984). The Maryland CNC Test: Normative studies. *Audiology, 23*, 552-568.

CaziSoft, LLC. (2012). P Stopwatch (Version 1.0.0) [Mobile application software]. Retrieved from http://www.cazisoft.com/application-support

Davies, R., Rodríguez-Ferreiro, J., Suárez, P., & Cuetos, F. (2012). Lexical and sub-lexical effects on accuracy, reaction time and response duration: Impaired and typical word and pseudoword reading in a transparent orthography. *Read Writ, 26,* 721-738. doi: 10.1007/s11145-012-9388-1

Duff, F. J. & Hulme, C. (2012). The role of children's phonological and semantic knowledge in learning to read words. *Scientific Studies of Reading, 16*(6), 504-525.

Fink, R. B., Schwartz, M. F., & Myers, J. L. (1998). Investigations of the sentence-query approach to mapping therapy. *Brain and Language, 65*, 203-207.

Fisher, D. (2001). Early language learning with and without music. *Reading Horizons, 42*(1), 39-49.

Francis, W.N., & Kucera, H. (1982). *Frequency analysis of English usage: Lexicon and grammar*. Boston: Houghton Mifflin.

Hansen, D. & Milligan, S. A. (2012). Aural skills: A juncture of research in early reading and music literacy. *Music Educators Journal, 99*(75), 75-80.

Hurwitz, I., Wolff, P. H., Bortnick, B. D., & Kokas, K. (1975). Nonmusical effects of the Kodaly Music Curriculum in primary grade children. *Journal of Learning Disabilities, 8*(3), 167-174.

Inglebret, E., Jones, C., & Pavel, D. M. (2008). Integrating American Indian/Alaska Native culture into shared storybook intervention. *Language, Speech, and Hearing Services in Schools, 39,* 521-527.

James, K. H. (2010). Sensori-motor experience leads to changes in visual processing in the developing brain. *Developmental Science, 13*(2), 279-288. doi: 10.1111/j.1467-7687.2009.00883.x

James, K. H. & Atwood, T. P. (2009). The role of sensorimotor learning in the perception of letter-like forms: Tracking the causes of neural specialization for letters. *Cognitive Neuropsychology, 26*(1), 91-110. doi: 10.1080/02643290802425914

James, K. H. & Gauthier, I. (2006). Letter processing automatically recruits a sensory-motor brain network. *Neuropsychologia, 44*, 2937-2949.

James, K. H. & Swain, S. N. (2011). Only self-generated actions create sensori-motor systems in the developing brain. *Developmental Science, 14*(4), 673-678. doi: 10.1111/j.1467-7687.2010.01011.x

Kelley, L. (1981). *A combined experimental and descriptive study of the effect of music on reading and language.* (Unpublished doctoral dissertation). University of Pennsylvania, Philadelphia, PA.

Kieffer, M. J. & Vukovic, R. K. (2012). Growth in reading-related skills of language minority learners and their classmates: More evidence for early identification and intervention. *Reading and Writing, 26,* 1159-1194.

Kohnert, K., Yim, D., Nett, K., Kan, P. F., & Duran, L. (2005). Intervention with linguistically diverse preschool children: A focus on developing home language(s). *Language, Speech, and Hearing Services in Schools, 36*, 251-263.

Kroenke, K-M., Mueller, K., Friederici, A. D., & Obrig, O. (2012). Learning by doing? The effect of gestures on implicit retrieval of newly acquired words. *Cortex,* http://dx.doi.org/10.1016/j.cortex.2012.11.016

Levelt, W. J. M., Roelofs, A. & Meyer, A. S. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences, 22,* 1-75.

Miller, J. & Schwanenflugel, P. J. (2006). Prosody of syntactically complex sentences in the oral reading of young children. *Journal of Educational Psychology, 98*(4), 839-843.

Mitchum, C. C. & Berndt, R. S. (2008). Comprehension and production of sentence. In Chapey, R. (Ed.). *Language Interventions strategies in Aphasia and Related Neurogenic Communication Disorders* (pp.632-653). Baltimore, MD: Lippencott, Williams & Wilkins.

Mitchum, C. C., Haendiges, A., & Berndt, R. S. (1993). Model-guided treatment to improve written sentence production: A case study. *Aphasiology, 7*, 71-109.

Norris, J. A. & Hoffman, P. R. (1990). Language intervention within naturalistic environments. *Language, Speech, and Hearing Services in Schools, 21*, 72-84.

Raymer, A. M. & Ellsworth, T. A. (2002). Response to contrasting verb retrieval treatments: A case study. *Aphasiology, 16*(10/11), 1031-1045.

Raymer, A. M. & Rothi, L. J. G. (2008). Impairments of word comprehension and production. In Chapey, R. (Ed.). *Language Interventions strategies in Aphasia and Related Neurogenic Communication Disorders* (pp.607-631). Baltimore, MD: Lippencott, Williams & Wilkins.

Ritter, M., Colson, K. A., & Park, J. (2012). Intervention using interactive metronome in children with language and reading impairments: A preliminary investigation. *Communication Disorders Quarterly, 20*(10), 1-14. Doi: 10.1177/1525740112456422

Rose, M. & Douglas, J. (2003). Limb apraxia, pantomime, and lexical gesture in aphasia speakers: Preliminary findings. *Aphasiology, 17*(5), 453-464.

Rose, M., Douglas, J., & Matyas, T. (2002). The comparative effectiveness of gesture and verbal treatments for specific phonologic naming impairment. *Aphasiology, 16*, 1001-1030.

Roth, F. P. & Worthington, C. K. (2011). *Treatment Resource Manual for Speech-Language Pathology.* Clifton Park, NY: Delmar, Cengage Learning.

Santore, F. (2006). Sounds in motion: Phonemic awareness. In *Advance for Speech-Language Pathologists and Audiologists* (August 21, 2006). Retrieved from http://speech-language-pathology-audiology.advanceweb.com/Editorial/Content/Editorial.aspx?CC=76693

Silverberg, N., Vigliocco, G., Insaluco, D., & Garrett, M. (1998). When reading a sentence is easier than reading a little word: The role of production processes in deep dyslexics reading aloud. *Aphasiology, 12*, 335-356.

St. Clair, R. & Phipps, A. (2008). Ludic literacies at the intersections of cultures: An interview with James Paul Gee. *Language and Intercultural Communication, 8*(2), 91-100. doi: 10.1080/14708470802270950

Standley, J. M. (2008). Does music intervention help children learn to read? Evidence of a meta-analysis. *Update: Applications of Research in Music Education ,27*(17), 17-32.

Stevens, R. J., Madden, N. A., Slavin, R. E., & Farnish, A. M. (1987). Cooperative Integrated Reading and Composition: Two field experiments. *Reading Research Quarterly, 22*(4), 433-454.

Telian, N. A. & Castagnozzi, P. (2001). Lively letters. *Reading with TLC.* Retrieved from http://www.readingwithtlc.com/index.html

Truesdale, S. P. (1990). Whole-body listening: Developing active auditory skills. *Language, Speech, and Hearing Services in Schools, 21*, 183-184.

U.S. Department of Education, What Works Clearinghouse: Institute of Education Sciences. (2012). *Early childhood education interventions for children with disabilities:*

Phonological awareness training (IES Publication No. ED533087). Retrieved from http://www.eric.ed.gov/PDFS/ED533087.pdf

Wakefield, E. M., James, T. W., & James, K. H. (2013). Neural correlates of gesture processing across human development. *Cognitive Neuropsychology, 30*(2), 58-76. doi: 10.1080/02643294.2013.794777

Weiner, I. B., Lerner, R. M., & Easterbrooks, M. A. (2012). *Handbook of psychology, developmental psychology* (2nd ed.). Somerset, NJ: Wiley.

Wiener, J. & Harris, P. J. (1997). Evaluation of an individualized, context-based social skills training program for children with learning disabilities. *Learning Disabilities Research & Practice, 12*(1), 40-53.

Vinden. D., Rowsell, C., Wernham, S., & Lloyd, S. (1987). Jolly phonics. *Jolly Learning Education Publisher.* Retrieved from http://jollylearning.co.uk/

Ylvisaker, M., Szekeres, S. F, & Feeney, T. (2008). Communication disorders associated with traumatic brain injury. In Chapey, R. (Ed.). *Language Interventions strategies in Aphasia and Related Neurogenic Communication Disorders* (pp.879-962). Baltimore, MD: Lippencott, Williams & Wilkins.

ABSTRACT

THE INFLUENCE OF GESTURAL LEARNING ON ORAL READING AND READING COMPREHENSION

by

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Major: Communication Sciences and Disorders

Degree: Master of Arts

The purpose of this project was to evaluate how gestural training may facilitate oral reading and reading comprehension of novel script. It is not clear whether multi-modal cues such as gesture provide an advantage over verbal cueing alone, or which type of multi-modal cues may be more effective than others in visual-verbal learning. There is some evidence that interacting with objects appears to change how the objects are perceived visually and active writing of letter shapes has been found to promote visual perception of letters. Examining language learning in healthy volunteers can provide clues to effective methods for language intervention in individuals with language difficulties.

In the current study, the effects of gesture training on learning of visual-verbal associations were examined in 32 healthy, literate adults in a task of reading single words presented in novel script. Visual-verbal associations were trained under four conditions: Verbal Cue Alone, Verbal Cue Plus Meaningful Gesture, Verbal Cue Plus Visual Tracing Gesture, and Verbal Cue Plus Meaningless Gesture. Immediate recall was measured using an oral reading task, and delayed retention was measured using a verification task as a test of comprehension.

It was predicted that participants would perform fastest and most accurately in oral reading and comprehension of novel script that was trained using meaningful gesture, followed by training with the visual tracing cue, then verbal training alone, and finally, verbal plus meaningless gesture.

Contrary to expectations, training of visual-verbal associations with a verbal cue alone led to significantly higher accuracy in oral reading as compared to the three gesture conditions. Also, oral reading accuracy rates were significantly higher in the Verbal Plus Visual Tracing condition than in the Verbal Plus Meaningful Gesture condition. In the comprehension task, training in the Verbal Cue Alone condition led to significantly more accurate performance than the Verbal Plus Meaningful Gesture condition and the Verbal Plus Meaningless Gesture condition. Comprehension accuracy rates were significantly higher in the Verbal Plus Visual Tracing condition than in the Verbal Plus Meaningful Gesture condition.

Possible explanations for these results are discussed. Superior performance for words trained with a verbal cue alone may reflect increased demands on visual attention in the three gesture training conditions. Further research is needed to address the specificity of these effects, particularly in persons with language delay or disruption.

AUTOBIOGRAPHICAL STATEMENT

As a graduate student in speech-language pathology, I am passionate about the work I have completed in the classroom and in the clinic. Among the information that I have learned, I have recognized that there is a significant lack of evidence based practice in the field of speech-language pathology. With this knowledge, I chose to combine my clinical experiences with my personal research practices. My passion for children and their opportunity to learn language has always been a part of me; however, during a rotation in the on-campus clinic, I was encouraged to further explore the effectiveness of language learning in children who were impaired and/or had limited opportunities to learn.

Through my research, I hope to help disadvantaged children learn language through modalities of communication that most effectively help them to learn. My hope is that all children are able to understand a spoken language and therefore have the opportunity to be successful in life. Also, as I am an avid reader and enjoy the feeling of stories coming to life, I desire that children be able to feel these emotions while simultaneously opening a new door to learning and communicating.

Instead of using children as participants, healthy adult volunteers were presented a series of learning conditions to understand more about the factors that affect language learning. Hopefully, the results of the effective learning strategies will later be studied in treatment sessions with children.