INVESTIGATING THE EFFECTS OF PROMPTING AND REINFORCEMENT TO TEACH LIPREADING

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Katherine Elizabeth Ross

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Department of Speech Pathology
Abstract

of

INVESTIGATING THE EFFECTS OF PROMPTING AND REINFORCEMENT TO TEACH LIPREADING

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Katherine Elizabeth Ross

Studies have shown that including lipreading instruction as a component of aural rehabilitation therapy may improve a person's lipreading performance (Bernstein, Auer, & Tucker, 2001). Various methods to teach lipreading have been proposed as part of aural rehabilitation therapy; however, little empirical evidence has been demonstrated to support any particular method. Behavior analytic research has demonstrated the efficacy of the use of prompts and reinforcement to teach verbal behavior. The purpose of the first study was to test whether the use of prompt delay procedures combined with programmed reinforcement and error correction would be effective in teaching lipreading. In this study, five adults ages 74 to 88 with moderate to severe hearing loss were taught 10 five-sample sets of words. Results indicated that for all participants the use of prompt delay procedures combined with programmed reinforcement and error correction procedures were effective in teaching lipreading. Generalization and maintenance probes indicated variable performance. A second study was conducted to assess the effects of specific stimulus selection and recombination on rates of
generalization and maintenance. Two adults ages 23 and 25 with normal hearing were taught 5 five-sample sets of syllables. The syllables were then combined and recombined to form real words during post-testing. Results indicated that for both participants teaching lipreading to carefully selected stimuli was effective at producing increases in response generalization and maintenance.

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Chapter 1

Study 1

INTRODUCTION

Speech recognition refers to the use of auditory and visual signals used to understand spoken information (Tye-Murray, 2009). The process whereby individuals develop speech recognition of phonemes, words, and sentences during face-to-face conversation is through attention to the speaker’s words, mouth movements, facial expressions, and gestures. This attention to both the auditory and visual signals is termed speechreading. Because speechreading uses all modalities commonly present in typical communication, this method is utilized by individuals with and without hearing loss (Jeffers, 1971). However, for individuals with hearing loss, the auditory signal may be reduced or altogether not present. In these cases, visual signals become the primary component influencing speech recognition. Lipreading is the process of speech recognition when only visual signals are used and for individuals with hearing loss it becomes their primary mode of speech recognition (Duchnowski, Braidia, Bratakos, Krause, and Lum, 2000).

The prevalence of Americans with hearing loss has increased by 50% in the last 30 years (ASHA on the Prevalence and Incidence of Hearing Loss in Adults, n.d.). While the effects of hearing loss may be mitigated with the use of a hearing aid, maintenance of communicative skills may be enhanced through the use of lipreading (Fraser, Gagne, Alepins, and Dubois, 2010). These benefits also extend to individuals’
daily activities such as functioning in noisy environments (Bunger, 1961; Jeffers, 1971) and increase the effectiveness of a hearing aid or cochlear implant (Arnold, 1997). Direct instruction by an audiologist or speech pathologist in lipreading is one of the components of aural rehabilitation therapy. Aural rehabilitation was not considered an important piece of the audiologist’s responsibilities for many decades leading up to the 1990’s as hearing aid technology began to develop. However, in the last 20 years, it has regained its prominence and the important components of aural rehabilitation therapy, such as lipreading, are becoming popular aspects of therapy once again (McCArthy & Schau, 2008). Professionals in the fields of speech pathology and audiology are in need of training procedures to be developed so that lipreading training may be even more effective and beneficial (Tye-Murray, Sommers, & Spehar, 2007).

While the benefits of lipreading for populations with hearing loss have been documented, less is known about the variables that may affect a listener’s comprehension during lipreading. A complex interaction of a variety of factors including environmental, speaker, lipreader, and message affect visual speech perception (Jackson, 1988, Bernstein, Demorest, and Tucker 2002; Kricos & Lesner, 1982; Lesner & Kricos, 1981). Environmental factors that can affect lipreading are lighting, distance, and distractions. Difficulties induced by a speaker include the speakers’ range of movement of their articulators (i.e., mouth, jaw, dentition, lips, and tongue), accents, rate of speech, and sounds that appear identical on the lips (visemes) which all affect recognition and comprehension (Tye-Murray, 2009). The lipreader’s current skill level also affects their ability to recognize speech sounds as
well as the speaker’s familiarity with the listener and complexity of the message (Lansing & Helgeson, 1995). Even under ideal environmental and historical conditions, phonetic information invisible to the lipreader can further hinder comprehension (Auer, 2009). Despite these barriers to lipreading, training in lipreading will give the client not only a foundational skill, but also teach strategies on how to compensate for the phonemes that are not visible.

Although lipreading seems to improve with practice (Summerfield, 1983), some argue that the skill is innate and that any attempts to teach lipreading will be futile (Heider & Heider, 1940; Jeffers & Barely, 1971, Montgomery & Sylvester, 1984). This perspective appears to have little empirical support and several studies have shown that including lipreading instruction as a component of aural rehabilitation therapy improves a person’s lipreading performance (Bernstein, Auer, & Tucker, 2001; McCarthy & Schau, 2008; Auer, 2009; Alacantra, Cower, Blamey, and Clark, 1990).

For many years it was thought that individuals with hearing loss “automatically” became better lipreaders than those with normal hearing because of their reduced access to the auditory signal. However, studies have demonstrated that an acquired hearing loss does not result in any experientially based advantage for visual speech perception compared to hearing individuals (Clouser, 1977; Conrad, 1977; Lyxell & Ronnberg, 1991; Massaro, 1987; Summerfield, 1991). Therefore, receiving explicit lipreading instruction is especially important for those who have a hearing loss as they will not acquire this skill on their own (Jeffers & Barely, 1971; McCarthy & Schau, 2008).
Traditional Methods of Lipreading Instruction

Lipreading has been taught to those with hearing loss in the United States since the beginning of the 1900’s (Tye-Murray, 2009). Traditional lipreading methods belong in two categories that differentiate in their approach to teaching: analytic and synthetic. An analytic approach emphasizes recognition of individual speech sounds or syllables, while the synthetic approach emphasizes understanding of an entire utterance, not the recognition of each individual word (Tye-Murray, 2009).

The basis of the analytic method is to develop vowel and consonant recognition skills. It is sometimes done in absence of voice, but also increases reliance on the auditory signal for discriminating between individual phonemes while a person lipreads. A person is taught to discriminate between small linguistic units. Often, training begins by teaching individual phonemes and students are taught to recognize the distinct visual differences between them. Next, they are combined in syllables teaching discrimination between phonemic combinations. Finally, whole words are trained. Critics of the analytic method state that due to visual similarities amongst phonemes and words, context is required in order to understand the message. The synthetic approach is context based. It emphasizes the lipreader’s understanding of the entire spoken message. Individuals are not taught to identify each individual unit of speech (e.g. syllable, phoneme), but rather are taught to recognize the meaning of a sentence through context. The main advantage of the synthetic method is that a person is able to gain information from context, the other words in the story, and the speakers’ facial expression in order to derive the meaning of the spoken utterance.
Currently, there are four traditional methods of lipreading training: The Mueller-Walle Method, the Nitchie Method, The Kinze Method, and the Jena Method (Tye-Murray, 2009). Each was founded in the early 1900s and includes aspects of both the analytic and synthetic approaches. Empirical research supporting any of these methods is quite limited.

The Mueller-Walle method was introduced to the US in 1902 by Martha Emma Bruhn. Today, her method is considered an analytic approach to teaching lipreading. Her training method utilizes drills that break down words into smaller linguistic units such as syllables and sounds. Bruhn emphasized spending less time on explaining the mechanics of how to lipread, and more time on direct practice (Bruhn, 1949). A hallmark of the Mueller-Walle method is the rapid, rhythmic syllable drill. This drill is the foundation for comprehending words and sentences according to Bruhn. She suggests that once a student is able to master the syllable drill they would perform much better when applying it in sentences (Bruhn, 1930). The syllable drill was made up of at least two syllables which have contrasting movements and rhythm (Bruhn, 1949). An example would be *she-may-flea* and *she-may-free* (Tye-Murray, 2009). The student began with easy syllable drills and as they progressed the drill sets became gradually more difficult (Bruhn, 1930). Bruhn states that they should be given rapidly until the student is able to read them fluently.

In her training the students also worked on identifying homophoneous words. Homophones are words that appear the same on the lips (e.g., meat and beat). According to Bruhn, 50% of words in the English language are homophones. Because
of this, she considered identifying words at the single word level was not useful, and that training should only be done at a sentence level so that one can use the context of the sentence to understand the meaning of the word. This exercise is more similar to a synthetic approach than analytic since it uses sentence context to correctly identify the word. This demonstrates the continuum between analytic and synthetic approaches and there is often not a clear distinction between the two.

Bruhn has written many books that give detailed lipreading lessons (Bruhn 1949). She begins each lesson with a review of the sounds that have been previously learned and then discusses how they appear on the lips. Next she introduces the new sounds that will be taught and explains the movement of the articulators when producing the new sound. In the beginning stages of Bruhn’s lipreading training she has her students use word-for-word repetition so that the eyes will accurately identify what has been said. Word for word repetition means that the speaker mouths a word and the lip reader repeats what they believe the speaker has said. This provides immediate feedback regarding whether they have lipread correctly or not. She suggests that this should only be used in the beginning as a “crutch” and should be eliminated from therapy as soon as possible. Bruhn also stated that when teaching you should always use your voice. Her reasoning was that if the student is able to hear, but is taught to lipread with no sound, when he/she goes into the real world he/she will strain to hear rather than rely on the lipreading skills he/she has been taught. By using voice while teaching lipreading Bruhn thought the skill would be able to be generalized out of the therapy room. In the past century since this method has been developed, no
empirical research has been conducted to demonstrate the efficacy of this method in teaching lipreading. Despite the availability of work books describing how to conduct this therapy (Bruhn, 1930, 1949), no controlled studies are available.

The Nitchie Method was introduced by Edward B. Nitchie in 1912. This method is considered a synthetic approach because of the emphasis placed upon the psychological process of lipreading (Tye-Murray, 2009; Nitchie, 1950). Nitchie thought that while the eyes must be trained to recognize speech, the more important factor in learning to lipread is that the mind is trained to recognize speech (Nitchie, 1950). His methods stress that we must not only train the eyes to be accurate; we must train the mind to read what has been said subconsciously (Nitchie, 1930). He believed that the eyes may quickly see the spoken words correctly, but the mind may take a longer time to process what has been said. Therefore, the student is expected to have a quick response when asked to repeat what was mouthed so that the mind will be forced to be quick as well. Also, Nitchie called for all teachers to speak at a normal, rapid rate. In actual conversations people will not speak slowly, so he thought that one must practice in an environment that will be similar to conditions experienced in every day speech.

Unlike Bruhn, the Nitchie method rarely uses syllable drill as practice (Tye-Murray, 2009). He emphasized the importance of understanding the whole spoken message, whether it is a sentence or a story. This is the reason his method is considered a synthetic approach to lipreading. As a training procedure, he would not allow his pupils to interrupt and ask for clarification in the middle of a sentence because at the
end of a sentence the mind may “all of a sudden” understand the entire thing; therefore, one must wait until the teacher has finished speaking (Nitchie, 1930). Practice for homophoneous words was also conducted in sentence tasks so that the student may derive the meaning of the word through context. Nitchie used stories and humorous anecdotes for training materials to affect mind training (Tye-Murray, 2009).

Nitchie believed that one should have practice both with and without the voice (Nitchie, 1950). The rationale for this was that hearing the voice should be used in practice so that the lipreading skill may generalize. However, he also says that there should be some practice with no voice. Similar to the Mueller-Walle Method, there is no empirical research to show this method as an effective way to teach lipreading.

The Kinze method of lipreading training was introduced by Cora Kinze and her sister, Rose, in 1917 (Tye-Murray, 2009). Their method was influenced by both the Bruhn and Nitchie methods and utilizes a combination of the two approaches. As such, this method is comprised of both analytic and synthetic training exercises. The Kinze method emphasized the rapid syllable drill used by Bruhn, along with the importance of understanding the meaning as a whole from the Nitchie method. No empirical research has been done to assess the effectiveness of this method.

Finally, the Jena method, introduced by Karl Brauckmann, and translated by Anna M. Bunger in 1961 is mainly an analytic approach, although there are some synthetic exercises as well. Brauckmann states there are five forms of speech: audible, visible, movement, mimetic, and gesture (Bunger, 1961). For an individual who has at least some hearing loss the audible form will be incomplete and therefore lipreading
instructions should emphasize the visible, movement, mimetic, and gesture forms. He emphasizes the importance of knowledge of vowels and consonants before beginning training (Bunger, 1961). Consonants are not taught by their visible appearance, but by their classification of being produced by the lips, tongue, or tongue-soft palate (Jeffers, 1971). Vowels are taught by memorizing a basic vowel order rather than each vowel being taught. Each lesson done in the Jena Method typically includes three types of practice: syllable exercises, practice using series of words in the same “thought groups”, and context practice using longer stories (Bunger, 1961). A three-fold focus in this method is imitation, kinesthetic sensation, and rhythm. The learner imitates the speaker’s jaw movement, focuses on the kinesthetic sensations they are making, and each vowel and consonant sound is presented with rhythm. A study conducted by De Filippo et al. (1995) found that having participants view their own speech (via a recording) after speech-production practice increased accuracy of identifying trained and untrained words compared to participants who only viewed the trainer’s speech. This supports Bunger’s theory that mimetic and kinesthetic practice increase lipreading ability. This method does not contain a set rule regarding voicing while teaching lipreading. He suggests that one will become an expert lipreader if they are able to completely learn without voice; however, for those who have some hearing, it is okay to use voice during lessons. Although component research related to this method has been conducted, there is no empirical research demonstrating the effectiveness of the teaching method as a whole.
A more recent approach to lipreading training is the holistic approach (Tye-Murray, 2009; Arnold, 1997). It was developed by Yoshinaga-Itana (1988) and is used to teach lipreading to children. Her approach is a top-down method, similar to the synthetic approach. The holistic approach is used so that the child will understand the meaning of a whole phrase rather than focus on each individual word that is said. The holistic approach incorporates the children into the planning and goal setting as a motivational tool. By doing this, they are believed to be more invested in the process of learning to lipread. The goals are to increase the child’s knowledge of the process of speechreading, to increase their ability to generate strategies to use successfully in communication, to enable them to have tolerance in stressful communication situations, help them create personal goals for success, and to increase their motivation to learn to lipread. A similar approach to the holistic approach is the linguistic approach by Raymond Hull. It also emphasizes the importance of teaching lipreading as a whole rather than individual parts; however, the main difference is that it requires the learner to rely on what residual hearing they have left to aid in the lipreading (Hull, 1971).

Cued Speech is another method of lipreading instruction. This method combines the use of hand and lip movements to supplement the visual signal and give clarity regarding the speaker’s message (Cornett, 1967). Because most of the phonemes in the English language have visemes (sounds that appear identical on the mouth /p,b,m/ or /t,d,l,n/) a hand signal is used to correspond to the phoneme so that the listener may recognize which sound has been spoken. Studies have demonstrated that
for deaf individuals, the implementation of cued speech produces higher rates of recognition of sounds and syllables than those who were trained by lip movements alone (Cornett, 1975; Rupert, 1969; Schiller, 1974; Nichols & McGill, 1982; Iwata & Neef, 1985). It is hypothesized that the use of cued speech may help facilitate the transfer of stimulus control from the hand signal and lip movements to the lip movements alone (Iwata & Neef, 1985). This is assuming that the students are attending to the lip movement and not only the hand movement. A disadvantage of this method is that it may not generalize the skill to speechreading outside of a cued speech environment.

Age can also be a factor in the success that one has when learning to lipread (Arnold, 1997). Many of the individuals who are learning to lipread for their first time are in later adulthood and have experienced some type of hearing loss and are trying to compensate by learning to lipread. Younger adults also perform better than older adults on lipreading tasks (Feld, & Sommers, 2009). Feld and Sommers (2009) investigated the differences of working memory, information processing speed, perceptual skills, and lipreading skills in young adults versus older adults. Tasks were given to evaluate these four areas. They found that the group of older adults had significantly lower lipreading and perceptual skills. Also the older group had shorter working memory and slower processing speeds than the younger group. They believe the differences in working memory, processing speeds, and perceptual skills directly affect a person’s ability to lipread.
Although there have been many methods used over the past 100 years, professionals in the fields of speech pathology and audiology do not broadly agree that any of these methods as a whole are effective at teaching lipreading. It is evident that there is a shortage of research in the fields of speech pathology and audiology for evidence-based methods and there has been a call for new research for the development of effective methods for teaching lipreading (McCarthy & Schau, 2008). Best practice is based on empirical research rather than best guess approaches (DeLand, 1968).

Prompting and Reinforcement

Prompting and reinforcement have been used to teach a variety of skills, including communication or verbal skills (Bondy & Erickson, 1976; Charlop, Schreibman, and Thibodeau, 1985; Coleman-Martin & Wolff Heller, 2004; Coon & Miguel, in press; Kale, Kaye, Whelan, and Hopkins, 1968; Knapczyk & Livingston, 1974; Leaf, Sheldon, and Sherman, 2010). Prompts are additional stimuli that are presented simultaneously with or following an instruction and that increase the likelihood of the learner emitting a correct response (Cooper, 2007). Correct responses are then followed by delivery of a reinforcer. A reinforcer is a stimulus that follows a desired behavior to increase the likelihood of future occurrences of that behavior (Cooper, 2007). The process by which future occurrences of behavior occur is known as reinforcement (Skinner, 1953). This relationship between instruction, prompt, correct response, and reinforcement can be used to establish new behaviors and to maintain a pre-existing stimulus-response relationship (Touchette, Howard, 1984).
Through systematic fading of the prompting stimulus from the instruction, transfer of stimulus control from the prompt to the instruction is achieved. This is observed when, during later trials, correct responses occur following the instruction and no longer in the presence of the prompt. This procedure has been demonstrated to reduce, and in some cases eliminate altogether, the probability of errors occurring during training (Terrace, 1963). Reducing errors during training expedites skill acquisition by minimizing the number of trials to reach mastery.

Several studies have shown that the systematic fading of prompts can successfully reduce the production of errors during the transfer of stimulus control (Carbone, Sweeney-Kerwin, 2010; Charlop et al, 1985; Charlop, Walsh, 1986; Coon & Miguel, in press; Ingenmey, Van Houten, 1991). Charlop et al. (1985) used a time-delay prompting procedure to increase the spontaneous requests of children with autism. The examiner presented desired objects, such as cookies, to the children and initially used a model prompt for the desired response (e.g., “I want cookie.”). As the child demonstrated this vocalization following the presentation of the model prompt, the time between presentation of the item (e.g., cookie) and delivering the prompt was extended. By increasing the amount of time between presentation of the desired item and delivery of the prompt the child began to request the item independent of the prompt. All seven participants learned to request items spontaneously.

Many different types of prompts can be used to evoke desired behavior. One of the most common are verbal prompts like the ones used by Charlop et al. (1985) and may be used in a variety of settings. For example, they may be used in classrooms
where a teacher prompts a child who is reciting the Pledge of Allegiance by providing a word the child has left out. In a study by Kale et al. (1968), a group of schizophrenic adults were taught to initiate greetings using a verbal prompt. The experimenter would enter a room and if the participant did not initiate a greeting within ten seconds the verbal prompt was given (e.g., “Say ‘Hello!’”). After the participant responded correctly, a reinforcer was given. As the participant was successful with this level of prompt, the experimenter began fading the prompt. Next, the experimenter approached the participant and told him “I’m going to leave and come back, when I return I want you to say ‘Hello’”. The experimenter would leave and return within a few seconds with the reinforcer held up in near the participant’s face. When the participant appropriately greeted the experimenter he was given the cigarette. The experimenter gradually extended the period of time from a few seconds to a few minutes before returning and the reinforcer was also faded from in front of the participant’s face to in the experimenter’s pocket. By fading the prompt and reinforcement, the participant’s learned to initiate conversation in a more natural environment.

Other types of prompts include textual prompts (Cooper, 2007). An example of a textual prompt would be a teacher in the front of the classroom who holds up a sign that says quiet when the class is getting noisy. Many studies have shown that children with autism can be taught using textual prompts (Krantz & McClannahan, 1993,1998). In the 1993 study a textual prompt was used to teach initiation to peers. A contextually appropriate script was presented to the child during peer interactions (e.g., “Hey Amanda, would you like some candy?”). The child was prompted to read the text in
the presence of a peer. The script was systematically faded from end to beginning. For example, it may have reduced to “Hey Amanda, would you” to “Hey A”, to nothing so the presence of the peer along would cue initiation. This script fading procedure was proven successful in teaching social skills to children with autism. A textual prompt was also successfully used to teach children with different physical disabilities such as cerebral palsy how to spell (Coleman-Martin & Wolff Heller, 2004). In this study the child was given the vocal direction “spell (word).” The word was typed on an index card to be used as a textual prompt. Initially, the textual prompt was presented simultaneously with the vocal direction. As the child showed success the textual prompt was delayed by 5 seconds. If the child did not answer within the 5 seconds, the textual prompt was delivered. If the child answered incorrectly they were told to do it again and the prompt was delivered immediately. All three participants in this study showed success with this type of prompt and were able to maintain success after teaching, across probe trials.

Modeling can also be used as a prompt (Cooper, 2007). For example, if a parent asks his child to touch his nose, the parent may model by touching their own nose immediately upon giving the direction to increase the likelihood that the child’s response will be the desired behavior. Other prompts such as pointing, tapping, looking, or positioning an object closer to the individual may all be used as prompts as well and serve to better control a desired response or set of behaviors (Touchette & Howard, 1984).
Prompting and Reinforcement in Teaching Lipreading

While prompting and reinforcement have been used for years to teach speech to individuals with a variety of disabilities, no research has been conducted to explore the efficacy of prompts and reinforcement in teaching lipreading.

The type of prompt used during any teaching session depends upon the population and environmental arrangement. Because populations requiring aural rehabilitation have a reduced auditory signal, a textual prompt would be more appropriate than an auditory prompt. Also a visual prompt utilizes the same modality which a person uses to read lips and closely approximates the desired response. Keeping these similar would be beneficial since the goal is to transfer the stimulus control from the prompt to the naturally occurring stimulus (i.e., the lips and mouth).

There is debate amongst professionals about the most effective method of teaching lipreading (Bernstein et al., 2001). Because there is a lack of research to inform decisions, speech pathologists and audiologists often pick and choose between methods without empirical support for their decisions. Systematic application of prompting and reinforcement have proven to be very effective at teaching language in other related fields of verbal behavior. Research has not been conducted to investigate the efficacy of this method in teaching lipreading. It is hypothesized that this method of instruction may prove as an effective, or more effective, method at teaching lipreading than other traditional methods. The purpose of this study is to evaluate whether prompting and reinforcement would be effective in teaching lipreading to hard-of-hearing adults.
Chapter 2

METHOD

Participants, Setting, and Materials

Five adults, ages 74 to 88, with mild to severe hearing loss were recruited to be a part of this study. All participants received hearing screenings by the experimenter to ensure hearing loss of 30 dB or greater, but less than 90 dB. Participant’s eye sight was 20/20 either independent of corrective lenses, or with a corrective lens as reported by participants. Participants had near normal speech production as determined informally by the researcher. Participants were able to read as reported by the retirement home staff and shown by a sample reading passage. An interview with the staff was conducted to ensure selected participants did not have dementia or any psychological condition that would compromise the integrity of this study as reported by a social worker or medical personnel. Participants were given the Mini Mental Status Exam (Folstein, Folstein, McHugh, 1975) which screened for dementia and cognitive impairments prior to beginning the study to assess whether the participants selected should be able to complete the study.

Individual sessions were conducted two times a week for 60 minutes per day in a quiet area of their home with minimal distractions. Participants were seated across a table approximately 3 feet from the experimenter. Materials present during sessions were 3”x5” cards with words printed in 48 pt font, with Times New Roman lettering. These cards made up stimulus sets. The 5-word stimulus sets were used as textual prompts. All stimuli consisted of one word typed onto a 3”x5” card. The words chosen for training were monosyllabic and visually balanced as determined by Woodward
Degree of Visibility form and mathematical formula (sum of individual phoneme values divided by total number of phonemes, times 100). This formula was used to create sets of words that were of equal phonemic visibility so that one set was not easier than another (Woodward, 1960). Each set’s degree of visibility was within 62% to 75% visibility. Ten sets of 5 words were used during Multiple Exemplar Training. Words used in the study specific to each participant can be seen in Table 1.
### Table 1

**Words Counterbalanced Across Sets**

**Brett**

<table>
<thead>
<tr>
<th>Set 1</th>
<th>Set 2</th>
<th>Set 3</th>
<th>Set 4</th>
<th>Set 5</th>
<th>Set 6</th>
<th>Set 7</th>
<th>Set 8</th>
<th>Set 9</th>
<th>Set 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plane</td>
<td>Flag</td>
<td>Jam</td>
<td>Broom</td>
<td>Move</td>
<td>Bounce</td>
<td>Green</td>
<td>Black</td>
<td>Paint</td>
<td>Hair</td>
</tr>
<tr>
<td>Up</td>
<td>Play</td>
<td>Pail</td>
<td>Ear</td>
<td>Red</td>
<td>Street</td>
<td>Rock</td>
<td>Socks</td>
<td>Rich</td>
<td>Rip</td>
</tr>
<tr>
<td>Thumb</td>
<td>Wing</td>
<td>Knee</td>
<td>Desk</td>
<td>Train</td>
<td>Nail</td>
<td>Bag</td>
<td>Rose</td>
<td>Bus</td>
<td>Globe</td>
</tr>
<tr>
<td>Smoke</td>
<td>Home</td>
<td>Thread</td>
<td>Shirt</td>
<td>Pie</td>
<td>Fly</td>
<td>Cheese</td>
<td>Jump</td>
<td>Knife</td>
<td>Wheel</td>
</tr>
<tr>
<td>Turn</td>
<td>Egg</td>
<td>Cry</td>
<td>Fan</td>
<td>Feet</td>
<td>Shot</td>
<td>Wood</td>
<td>Grab</td>
<td>Land</td>
<td>Bell</td>
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</table>

**Megan**

<table>
<thead>
<tr>
<th>Plane</th>
<th>Flag</th>
<th>Jam</th>
<th>Frog</th>
<th>Mile</th>
<th>Type</th>
<th>Grab</th>
<th>Truck</th>
<th>Tongue</th>
<th>Paint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up</td>
<td>Play</td>
<td>Bird</td>
<td>Stop</td>
<td>Red</td>
<td>Street</td>
<td>Dark</td>
<td>Yes</td>
<td>Pie</td>
<td>Rug</td>
</tr>
<tr>
<td>Knife</td>
<td>Wing</td>
<td>Knee</td>
<td>Desk</td>
<td>Clock</td>
<td>Kiss</td>
<td>Bag</td>
<td>Bowl</td>
<td>No</td>
<td>Have</td>
</tr>
<tr>
<td>Smoke</td>
<td>Hand</td>
<td>Thread</td>
<td>Shirt</td>
<td>Nail</td>
<td>Blind</td>
<td>Glass</td>
<td>Don't</td>
<td>Ship</td>
<td>Lift</td>
</tr>
<tr>
<td>Turn</td>
<td>Egg</td>
<td>Cry</td>
<td>Fan</td>
<td>Feet</td>
<td>Shot</td>
<td>Wood</td>
<td>Sit</td>
<td>Land</td>
<td>Inch</td>
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</table>

**Jon**

<table>
<thead>
<tr>
<th>Plane</th>
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<th>Broom</th>
<th>Move</th>
<th>Bounce</th>
<th>Green</th>
<th>Black</th>
<th>Grab</th>
<th>Hair</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up</td>
<td>Thumb</td>
<td>Pail</td>
<td>Ear</td>
<td>Red</td>
<td>Street</td>
<td>Rock</td>
<td>Socks</td>
<td>Pie</td>
<td>Bird</td>
</tr>
<tr>
<td>Fan</td>
<td>Glass</td>
<td>Knee</td>
<td>Desk</td>
<td>Frog</td>
<td>Rich</td>
<td>Bag</td>
<td>Rose</td>
<td>Bus</td>
<td>Globe</td>
</tr>
<tr>
<td>Hand</td>
<td>Wing</td>
<td>Thread</td>
<td>Shirt</td>
<td>Nail</td>
<td>Fly</td>
<td>Cheese</td>
<td>Train</td>
<td>Knife</td>
<td>Wheel</td>
</tr>
<tr>
<td>Turn</td>
<td>Egg</td>
<td>Cry</td>
<td>Play</td>
<td>Feet</td>
<td>Stop</td>
<td>Wood</td>
<td>Where</td>
<td>Land</td>
<td>Bell</td>
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</table>

**Amber**

<table>
<thead>
<tr>
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<th>Flag</th>
<th>Jam</th>
<th>Cream</th>
<th>Shirt</th>
<th>Thumb</th>
<th>Green</th>
<th>Mile</th>
<th>Broom</th>
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</thead>
<tbody>
<tr>
<td>Sit</td>
<td>play</td>
<td>Church</td>
<td>Paint</td>
<td>bird</td>
<td>Street</td>
<td>Jump</td>
<td>Don't</td>
<td>Rug</td>
<td>Train</td>
</tr>
<tr>
<td>Glass</td>
<td>Wing</td>
<td>No</td>
<td>Kiss</td>
<td>Truck</td>
<td>Pie</td>
<td>Bag</td>
<td>Tongue</td>
<td>Bus</td>
<td>Globe</td>
</tr>
<tr>
<td>Smoke</td>
<td>hand</td>
<td>Thread</td>
<td>Ear</td>
<td>Nail</td>
<td>Frog</td>
<td>Dark</td>
<td>Grab</td>
<td>Type</td>
<td>Desk</td>
</tr>
<tr>
<td>Turn</td>
<td>Egg</td>
<td>Cup</td>
<td>Ship</td>
<td>Feet</td>
<td>Shop</td>
<td>Wood</td>
<td>Hair</td>
<td>Land</td>
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</table>

**Jerry**

<table>
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<tr>
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<th>Move</th>
<th>Bounce</th>
<th>Green</th>
<th>Black</th>
<th>Paint</th>
<th>Hair</th>
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</thead>
<tbody>
<tr>
<td>Up</td>
<td>Play</td>
<td>Pail</td>
<td>Ear</td>
<td>Red</td>
<td>Street</td>
<td>Rock</td>
<td>Socks</td>
<td>Pie</td>
<td>Rip</td>
</tr>
<tr>
<td>Thumb</td>
<td>Wing</td>
<td>Knee</td>
<td>Desk</td>
<td>Train</td>
<td>Nail</td>
<td>Bag</td>
<td>Rose</td>
<td>Straw</td>
<td>Bird</td>
</tr>
<tr>
<td>Smoke</td>
<td>Home</td>
<td>Thread</td>
<td>Shirt</td>
<td>Globe</td>
<td>Fly</td>
<td>Cheese</td>
<td>Jump</td>
<td>Knife</td>
<td>Wheel</td>
</tr>
<tr>
<td>Turn</td>
<td>Egg</td>
<td>Cry</td>
<td>Fan</td>
<td>Bus</td>
<td>Shot</td>
<td>Wood</td>
<td>No</td>
<td>Land</td>
<td>Bell</td>
</tr>
</tbody>
</table>
Experimental Design

A single-subject concurrent multiple probe design across participants was utilized (Kazdin, 1982). This procedure was used to assess the rate of generalization and compare the rate of acquisition across participants. In order to assess generalization, multiple exemplar training was used as described below.

Dependent Variables

The two dependent variables in this study were (a) number of blocks to criterion, and (b) number of sets to generalization. A block consisted of 15-trials of five stimuli with each stimulus repeated three times within a block in an unsystematic fashion. Mastery criterion was set at two consecutive blocks at 93% accuracy or better (14 of 15 trials correct). A correct response by the participant consisted of a vocal emission of the word mouthed (non-vocally) by the experimenter. An example of a correct response was if the experimenter presented the word “shirt” and the participant vocally responded, “shirt.” An example of an incorrect response was if the experimenter presented the target word and the participant responded with any other word than the target word. For example, if the examiner produced the word “shirt” and the participant vocally responded, “cat.”

Interobserver Agreement (IOA)

IOA data was assessed by an independent observer during 46.59% of the sessions. An agreement was defined as the examiner and the observer both scoring a response as correct or incorrect. A disagreement was defined as the examiner scoring a response that differed from the response scored by the observer. Interobserver
agreement was calculated on a trial-by-trial basis by dividing the number of agreements by the number of agreements plus disagreements within each block and multiplying by 100%. Agreement for responses across participants ranged from 96.4% to 99.7% IOA across all participants was 98.7%. Individual values for each participant can be seen in Table 2.

Table 2

*Interobserver Agreement (IOA)*

<table>
<thead>
<tr>
<th></th>
<th>Brett</th>
<th>Megan</th>
<th>Jon</th>
<th>Amber</th>
<th>Jerry</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td># Blocks</td>
<td>52</td>
<td>55</td>
<td>98</td>
<td>61</td>
<td>131</td>
<td>397</td>
</tr>
<tr>
<td># Blocks with IOA</td>
<td>24</td>
<td>34</td>
<td>54</td>
<td>22</td>
<td>51</td>
<td>185</td>
</tr>
<tr>
<td>% Blocks with IOA</td>
<td>46.1</td>
<td>61.8</td>
<td>55</td>
<td>36</td>
<td>38.9</td>
<td>46.59</td>
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<tr>
<td>IOA</td>
<td>99.7</td>
<td>99.6</td>
<td>96.4</td>
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<td>98.6</td>
<td>98.7</td>
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<td>Correct IOA Range</td>
<td>93-100</td>
<td>93-100</td>
<td>86-100</td>
<td>96-100</td>
<td>80-100</td>
<td>80-100</td>
</tr>
</tbody>
</table>

*Treatment Integrity*

Treatment integrity was assessed by an independent observer during at least 46.59% of the sessions. Antecedents and consequences were evaluated to ensure that they were delivered correctly in each trial presented by the examiner. A trial was scored as delivered correctly for antecedents if the examiner presented the correct target question specified on the data sheet in absence of voice, and presented the prompt with the appropriate time delay (if needed). Absence of voice was defined as the examiner mouthing a word with no audible sound serving as a prompt for the participant. A trial was scored as delivered incorrectly for the antecedent if the
examiner presented a different target question than what was specified on the data sheet, if the examiner used their voice, or if the prompt was not given at the appropriate time delay. A trial was scored as correct for the consequence if the examiner delivered the reinforcer within two seconds of the participant emitting the correct response or if the participant was incorrect and the examiner delivered the correct error correction procedure. Treatment integrity was calculated within each block dividing the number of correct trials by correct trials plus incorrect trials and multiplying this number by 100. Percentages for correct antecedents across participants ranged from 99.4% to 100%. Percentages for correct consequences across all participants was 100%. Treatment integrity across all participants was 99.68%. Individual values for each participant can be seen in Table 3.

Table 3

<table>
<thead>
<tr>
<th>Treatment Integrity (T.I.)</th>
<th>Brett</th>
<th>Megan</th>
<th>Jon</th>
<th>Amber</th>
<th>Jerry</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td># Blocks</td>
<td>52</td>
<td>55</td>
<td>98</td>
<td>61</td>
<td>131</td>
<td>397</td>
</tr>
<tr>
<td># Blocks with T.I.</td>
<td>24</td>
<td>34</td>
<td>54</td>
<td>22</td>
<td>51</td>
<td>185</td>
</tr>
<tr>
<td>% Blocks with T.I.</td>
<td>46.1</td>
<td>61.8</td>
<td>55</td>
<td>36</td>
<td>38.9</td>
<td>46.59</td>
</tr>
<tr>
<td>% Correct Antecedent</td>
<td>99.8</td>
<td>99.6</td>
<td>99.8</td>
<td>100</td>
<td>99.6</td>
<td>99.68</td>
</tr>
<tr>
<td>% Correct Consequence</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Correct Antecedent Range</td>
<td>93-100</td>
<td>93-100</td>
<td>86-100</td>
<td>96-100</td>
<td>80-100</td>
<td>80-100</td>
</tr>
<tr>
<td>Correct Consequence Range</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>
Procedures

Pre-training Assessment. Prior to baseline, a pre-training assessment was conducted to ensure that the participants could not correctly identify any of the to-be-trained stimuli. The experimenter voicelessly mouthed each word in the 10 sets of words to be trained. If a participant correctly identified any of the stimuli, the item was replaced with a stimulus that the participant did not recognize. If the participant responded with a homophenous word, it was considered correct and replaced with a word the participant did not recognize. Four of the five participants recognized words during this pre-training assessment. Because they each recognized multiple words differing from those recognized by each other, each participants’ word sets differed slightly. Figure 1 shows the word sets for each participant.

Baseline. The purpose of the baseline condition was to ensure that any behavioral change was due to the effects of the training procedures used during later conditions. During baseline, Set #1 was probed by voicelessly mouthing the words, in absence of the prompting stimulus card. No programmed consequences were used during baseline. Each word in Set #1 was given three times in an unsystematic fashion (see figure 2 for a sample data sheet). No words were presented more than one time in a row. If the participant responded by saying the correct word it was recorded as “correct.” If the participant failed to respond or responded incorrectly the word was scored as “incorrect.” A homophenous word list that corresponded with each target word was created to control for participant responses that matched the movement of the
experimenter’s mouth but was not the target word. During baseline if the participant was given the target word and responded with a homophenous word the response was counted as correct.

*Training.* Training was conducted to assess the effectiveness of prompts and reinforcement on the acquisition of target words. A progressive time delay procedure was implemented (Touchette, 1971) consisting of a 0 second (0s), 3 second (3s), and a final prompt phase consisting of no prompt. At the zero-second prompt delay, the experimenter presented the stimulus, then immediately held up the prompt (i.e., printed word). The participant read the word aloud and their answer was scored as correct with prompting. At the 3s level, the experimenter presented the stimulus and counted three seconds before presenting the prompt. The participant could respond before the prompt was delivered. If they responded correctly the answer was marked as independently correct. If they responded incorrectly it was marked as incorrect, and if they waited for the prompt before responding their response was scored as correct with prompt. At the independent level, the experimenter presented the stimulus in absence of a prompt and the participant had five seconds to respond to the stimulus. If they responded correctly it was scored as independently correct, if they responded incorrectly the experimenter would re-present the stimulus with an immediate prompt. During this prompting phase, if no response was given within the five seconds, the trial was scored as incorrect. Each word of the 5-word set was targeted three times in an unsystematic fashion, resulting in a 15-trial block. If the participant correctly responded to the target word, reinforcement in the form of non-descriptive praise was provided (e.g., “that’s right”, head nod,
“yes”, “great!,” Miguel, Petursdottir, & Carr, 2005). Mastery criterion was set at two consecutive blocks at 93% accuracy or better (14 of 15 trials correct) with respect to prompt level. Incorrect responses were followed by the error correction procedure consisting of the removal of any present materials, and immediately representing the target word with an immediate prompt (0 second delay). During training, if a participant responded with a homophenous word, it was recorded as “H” for homophone and the error correction procedure was implemented. If the participant responded incorrectly or with an homophonous word for three consecutive target words, the prompt delay was regressed to the previous level, and the participant had to again meet mastery criteria for two consecutive blocks to move to the next prompt level. Mastery criterion for each set was at least 93% accuracy (14 of 15 trials) for two consecutive blocks in the absence of prompts. Training was conducted until participants had met termination criteria or learned 10 sets. Sets were counterbalanced across participants. Table 4 shows the order of sets trained for each participant.

Table 4

Sets Counterbalanced

<table>
<thead>
<tr>
<th>Participant</th>
<th>1st Set</th>
<th>2nd Set</th>
<th>3rd Set</th>
<th>4th Set</th>
<th>5th Set</th>
<th>6th Set</th>
<th>7th Set</th>
<th>8th Set</th>
<th>9th Set</th>
<th>10th Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brett</td>
<td>Set 10</td>
<td>Set 7</td>
<td>Set 4</td>
<td>Set 6</td>
<td>Set 9</td>
<td>Set 5</td>
<td>Set 2</td>
<td>Set 1</td>
<td>Set 8</td>
<td>Set 3</td>
</tr>
<tr>
<td>Megan</td>
<td>Set 5</td>
<td>Set 8</td>
<td>Set 6</td>
<td>Set 2</td>
<td>Set 7</td>
<td>Set 4</td>
<td>Set 1</td>
<td>Set 3</td>
<td>Set 10</td>
<td>Set 9</td>
</tr>
<tr>
<td>Jon</td>
<td>Set 10</td>
<td>Set 7</td>
<td>Set 4</td>
<td>Set 6</td>
<td>Set 9</td>
<td>Set 5</td>
<td>Set 2</td>
<td>Set 1</td>
<td>Set 8</td>
<td>Set 3</td>
</tr>
<tr>
<td>Amber</td>
<td>Set 3</td>
<td>Set 8</td>
<td>Set 2</td>
<td>Set 7</td>
<td>Set 6</td>
<td>Set 1</td>
<td>Set 4</td>
<td>Set 5</td>
<td>Set 9</td>
<td>Set 10</td>
</tr>
<tr>
<td>Jerry</td>
<td>Set 2</td>
<td>Set 9</td>
<td>Set 5</td>
<td>Set 4</td>
<td>Set 10</td>
<td>Set 6</td>
<td>Set 8</td>
<td>Set 1</td>
<td>Set 3</td>
<td>Set 7</td>
</tr>
</tbody>
</table>

Generalization Probes. The purpose of a generalization probe was to assess participant identification of untrained, novel words. Generalization probes were identical to baseline and were comprised of novel 5-word sets. Generalization probes were conducted following mastery of each training set. Mastery criterion was set at
93% accuracy or better. If participant met mastery criterion for that set the generalization probe was given a second time. If the participant met mastery criterion twice in a row, generalization was assumed to be attained and the participant met termination criterion. If performance did not meet criteria during generalization probes that set was taught during training condition.

**Maintenance Probes.** Maintenance probes were conducted to assess whether the target words learned during the study maintained following completion of the study. Probes were conducted one month (4 weeks) following the completion of the study for each participant. Maintenance probes consisted of one trial of each target word (and novel words if applicable) learned in the study.
Chapter 3

RESULTS

Figure 1 shows the percentage of independent correct responses across 15-trial blocks for Brett and Megan during baseline, training, and generalization probes. Baseline sessions were conducted for two 15-trial blocks for Brett and three 15-trial blocks for Megan. Solid squares indicate vocal responses emitted during baseline conditions. Solid diamonds indicate vocal responses emitted during generalization probes. Solid triangles indicate the participants’ correct vocal responses in the absence of prompts during training, and the gray X’s indicate the vocal production of a homophenous word for the target word during baseline, training, or generalization probes. Termination criterion through generalization probes was not met with either participant; therefore, all 10 sets of words were trained.

During Brett’s first baseline session, he did not correctly identify any target words; however, he responded with homophenous words with 40% accuracy (6/15 trials). During his second baseline session he was 0% accurate for target words, but responded with homophenous words with 53% accuracy (8/15 trials). During the training condition for set 1, Brett answered correctly during 14 out of 15 trials or better in the absence of prompts in four blocks. After meeting criterion for set 1, the first generalization probe was administered. He was 20% accurate (3/15 trials) producing the target words and 6% accurate (1/15 trials) producing homophenous words. Brett met mastery criteria for training of sets 2 through 10 in four blocks each. Percentages of accuracy during generalization probes are as follows for the remaining probes 2-9...

During Baseline condition Megan correctly identified some target and homophenous words in each session. In her first baseline session she was 26% accurate (4/15 trials) producing target words and 46% accurate (7/15 trials) producing homophenous words. During the second baseline session, she was 6% accurate (1/15 trials) producing target words, and 40% accurate (6/15 trials) producing homophenous words. In her final baseline session, she correctly identified target words with 13% accuracy (2/15 trials), and identified homophenous words with 46% accuracy (7/15 trials). During the training condition Megan answered correctly during 14 out of 15 trials or better in the absence of prompts with sets 1 and 2 in 4 blocks each. Criterion was met for set 3 in 11 blocks. During the remaining sets 4 through 10, Megan met criterion in 4 blocks each. Percentages of accuracy during generalization probes are as follows for probes 1-9 respectively: 20% correct - and 0/15 target and 3/15 homophenous, 26% correct – 2/15 target and 2/15 homophenous, 66% correct – 5/15 target and 5/15 homophenous, 46% correct – 1/15 target and 6/15 homophenous, 93% correct – 8/15 target and 6/15 homophenous, 80% correct 4/15 target and 8/15 homophenous, 46% correct 7/15 target and 0/15 homophenous, 40% correct 2/15 target and 4/15 homophenous, 73% correct – 3/15 target and 8/15 homophenous.
Figure 1. Block-by-block acquisition data – Brett and Megan. Percentage of independent correct responses per block for Brett and Megan. Solid squares represent baseline responding. Solid triangles represent responses taught during training condition, open squares represent correct vocal productions during generalization probes, gray X’s represent vocal productions of homophoneous words, and open triangles represent correct responses during maintenance probes.

Figure 2 shows the percentage of independent correct responses across 15-trial blocks for Jon, Amber, and Jerry during baseline, training, and generalization probes. Baseline sessions were conducted for three 15-trial blocks for Jon, four 15-trial blocks for Amber, and five 15-trial blocks for Jerry. Solid squares indicate vocal responses emitted during baseline conditions. Solid diamonds indicate vocal responses emitted
during generalization probes. Solid triangles indicate the participants correct vocal responses in the absence of prompts during training, and the gray X’s indicate the vocal emission of a homophenous word for the target production during baseline, training, or generalization probes. Termination criterion through generalization probes was not met with any participant; therefore, all 10 sets of words were trained with each participant.

During Jon’s first baseline session he did not correctly produce any target words. In both second and third baseline sessions he correctly produced target words with 13% accuracy (2/15 trials). During the training condition Jon answered correctly during 14 out of 15 trials or better in the absence of prompts with sets 1 and 2 in 5 blocks each. For set 3, Jon met criterion in 4 blocks. He met criterion for set 4 in 5 blocks, set 5 in 27 blocks, set 6 in 10 blocks, set 7 in 4 blocks, set 8 in 8 blocks, set 9 in 8 blocks, and his final set 10 in 11 blocks. Percentages of accuracy during generalization probes are as follows for probes 1-9 respectively: 40% correct 3/15 target and 3/15 homophenous, 52% correct - 4/15 target and 4/15 homophenous, 40% correct - 3/15 target and 3/15 homophenous, 20% correct - 0/15 target and 3/15 homophenous, 46% correct - 3/15 target and 4/15 homophenous, 66% correct - 9/15 target and 1/15 homophenous, 13% correct – 0/15 target and 2/15 homophenous, 26% correct – 2/15 target and 2/15 homophenous, 13% correct – 0/15 target and 2/15 homophenous.

Amber also correctly produced target words and homophenous words throughout baseline. In her first baseline session she was 33% accurate (5/15 trials)
producing the target word and 33% accurate (5/15 trials) producing homophenous words. In her second baseline session she was 26% accurate (4/15 trials) producing the target word and 13% accurate (2/15 trials) producing homophenous words. During her third baseline session she was 33% accurate (3/15 trials) for producing target words and produced homophenous words with 33% accuracy (5/15 trials). During her last baseline session, Amber was 26% accurate (4/15 trials) producing the target word and 13% accurate (2/15 trials) producing homophenous words. During the training condition Amber answered correctly during 14 out of 15 trials or better in the absence of prompts for sets 1 and 2 in four blocks each. She met criterion for set 3 in 8 blocks. Criterion was met in 4 blocks each for sets 4 through 8. She met criterion for set 9 in 9 blocks, and met criterion for set 10 in 4 blocks. Percentages of accuracy during generalization probes are as follows for probes 1-9 respectively: 46% correct - 3/15 target and 4/15 homophenous, 33% correct - 0/15 target and 5/15 homophenous, 73% correct - 6/15 target and 5/15 homophenous, 93% correct - 6/15 target and 8/15 homophenous, 40% correct - 3/15 target and 3/15 homophenous, 33% correct - 0/15 target and 5/15 homophenous, 53% correct - 3/15 target and 5/15 homophenous, 33% correct - 0/15 target and 5/15 homophenous, 46% correct - 1/15 target and 6/15 homophenous.

Jerry did not correctly produce any target words or homophenous words during his first, second, third, or fourth baseline sessions. In his final baseline session he was 6% accurate (1/15 trials) for producing target words and did not produce any homophenous words. During the training condition Jerry answered correctly during 14
out of 15 trials or better in the absence of prompts for set 1 in 10 blocks. He met
criterion for set 2 in 24 blocks, set 3 in 13 blocks, set 4 in 10 blocks, set 5 in 7 blocks,
set 6 in 8 blocks, set 7 in 9 blocks, set 8 in 7 blocks, set 9 in 11 blocks, and set 10 in 18
blocks. Percentages of accuracy during generalization probes are as follows for probes
1-9 respectively: 0% correct, 6% correct - 1/15 target and 0/15 homophenous, 0%
correct, 13 % correct - 1/15 target and 1/15 homophenous, 0% correct, 26% correct -
0/15 target and 4/15 homphenous, 26% correct - 0/15 target and 4/15 homphenous,
13% correct -0/15 target and 2/15 homphenous, 0% correct.
Figure 2. Block-by-block acquisition data – Jon, Amber, and Jerry. Percentage of independent correct responses per block for Jon, Amber, and Jerry. Solid squares represent baseline responding. Solid triangles represent responses taught during training condition, open squares represent correct vocal productions during generalization probes, gray X’s represent vocal productions of homophenous words, and open triangles represent correct responses during maintenance probes.
Figure 3 shows the total number of blocks to criterion for each participant. Brett met criterion for the 10 sets in 51 blocks. Jon met criterion for 10 sets in 99 blocks. Megan met criterion for 10 sets in 59 blocks. Amber met criterion for 10 sets in 62 blocks. Jerry met criterion for 10 sets in 131 blocks.

![Bar chart showing trials to criterion](chart.png)

**Figure 3.** Blocks to criterion – All participants. Dark bars represent sets taught via textual prompts.

Figure 4 shows the percentage of independent correct vocal production of target words and homophenous words during the maintenance probes. Maintenance probes were conducted 1 month (4 weeks) following each participant completing the training for their 10th set. Brett had an overall accuracy rate of 50% for recognizing either the target word or its homophenous word. He produced 11 target words and 14
homophenous words. Jon was 52% accurate, producing 11 target words and 15 homophenous words. Megan was 62% accurate, producing 18 target words and 13 homophenous words. Amber was 66% accurate, producing 13 target words and 20 homophenous words. Jerry was 2% accurate, producing 0 target words, and 1 homophenous word.

![Graph](image)

Figure 4. Maintenance Probes – All participants. Darkest bars represent total percentage of correct responses. Lightest bars represent percentage of target words produced. Medium gray bars represent percentage of homophenes of the target words produced.
Chapter 4

DISCUSSION

This is the first study to directly assess the effects of via prompting and reinforcement in the establishment of lipreading. All participants in the current study learned all target words trained in the study when taught using a progressive prompt delay procedure and programmed consequences. Despite effective, this procedure produced limited maintenance of trained words during a four week follow up and failed to produce significant generalization to untrained words.

During teaching sessions, providing the prompt from the first trial removed any opportunity for the participant to make an error and increased the likelihood that all participants would respond successfully to trials from the beginning. The programmed consequences also served to maximize correct responses and decrease incorrect responses. It is likely that the manipulating both antecedents (prompts) and consequences (reinforcement) contributed to the acquisition of all target words in the current study.

Traditional lipreading methods have relied mostly upon trial and error. Trials in these methods typically consist of an opportunity to respond following a mouthed word but did not include any cue or prompt to increase the likelihood of a correct response by the learner. Subsequently, if the learner responded correctly they were told that they were correct. However, if an incorrect response was made, the learner was told that they were incorrect and a new trial began. Basic experimental research conducted by Terrace (1963) demonstrated that trials that occur with the use of cues significantly
reduce the number of errors made and increases the rate of acquisition. Reducing the number of errors produced is important as errors can make trials aversive for the participant (Terrace 1963). When a participant’s response is incorrect their percentage of accuracy decreases and the training period for that set of stimuli increases. Also, when participants respond incorrectly it can evoke an emotional response such as becoming frustrated or angry. For example, some of the participants from this study became upset when they were incorrect and it seemed to negatively affect the following responses which led to greater frustration. Therefore, using a systematic approach that reduces the likelihood of errors occurring is beneficial for learners.

Although all participants demonstrated success in learning all target words, response maintenance was limited across all participants in the study. As with any skill, performance over time is affected by opportunities to practice. The participants in this study all reported that their primary means of communication relied upon the auditory signal as opposed to visual signal. It is unclear whether maintenance would be higher among populations relying solely upon the visual signal. Additionally, there were no instructions given to participants to practice between the end of training and maintenance testing. It is possible that maintenance performance may have fared better among participants if rules were given to them to include individual practice outside of training. A common instruction given to clients undergoing aural rehabilitation includes paying attention to conversational partners’ mouths while speaking or practicing in a mirror between sessions.
Another variable possibly affecting maintenance of trained responses is the age of the participants. Age has been linked to both rate of skill acquisition and retention (Arnold, 1997; Feld & Sommers, 2009). Learning to lip read would likely be similarly affected. The trials to criterion data for the participants in this study show a similar pattern. In general, the older participants (i.e., participants over the age of 80) required more trials to criterion than participants under the age of 80, although this was not consistently the case. Brett (79 years) required the fewest number of trials to meet mastery across all 10 sets and was the median among all ages included in the study. Jerry (85 years) required the most trials to meet mastery and was the second oldest participant in the study. The degree of influence on participants’ acquisition and maintenance of targeted words is unclear. Although age is likely to be a contributing factor influencing the dependent variables measured in this study, it was not the variable of interest.

Although the current procedure demonstrated success in teaching lip reading to our target population, an equally important outcome is the failure to promote generalization to untrained words. Bear, Wolf, and Risely (1968) have noted that applied procedures intended to improve individuals’ skills should include special emphasis upon the generality of the skill taught. The following are a few hypothesized reasons that generalization may not have occurred. First, the 15-trial blocks and mastery criterion may have not been enough practice. It is possible that given enough training, generalization to novel exemplars would be demonstrated. Nonetheless, none of the participants in this study demonstrated any increasing trend in generalization
across additional sets as would be expected if practice alone is sufficient to this effect. In fact, generalization probes across sequential sets within participants show highly variable percentages of accuracy to novel exemplars. Furthermore, for four of the five participants, initial generalization probe percentages were not the lowest among the nine total probes.

Another possible reason for the failure to produce response generalization could be that the target words may not have sufficiently sampled the range of visual productions tested in generalization probes. While each set of words was visually balanced so that one set would not be more visually difficult than another set, this did not ensure that all possible combinations and phonemes were expressed within the selected word sets. Therefore, the participant would not correctly identify a novel word when its individual phonemes may not have been previously taught. This is supported by the fact that all words answered correctly during generalization probes contained at least one phoneme that had been previously trained. However, the majority of the words that the participants did not correctly identify also contained at least one phoneme.

**Limitations.** Although the current teaching method suggests an effective and efficient way to teach lip reading, there are some limitations that must be noted. First, there was no standardization of time between sessions. Training sessions were conducted according to participants’ schedules. Additionally, Jerry, who needed the most amount of training, was easily fatigued by the training sessions and requested to have them more spread out in order to give himself a break. It is possible that those
who were presented with the words within a shorter period of time had an advantage since they were exposed to the words more frequently. However, no sessions occurred more than a week apart and this schedule is in line with scheduled training sessions that occur in clinical practice. Additionally, it is important to note that maintenance sessions were standardized across participants. All maintenance sessions were conducted four weeks following completion of training for each participant. Second, there was no control for the quality of the social praise that was given after correct productions. Some participants smiled and nodded their heads in response to the statements such as “you’re right” and “great”, while others made statements such as, “Well of course I’m right, I know how to read a flashcard.” For these participants less affect was used and a monotone voice was used to reply, “yep”, “right”, “uh-huh” or “good” or a head nod as reinforcement for correct responses. However, all participants met criterion during training, suggesting this feedback was effective as a reinforcer.

**Future Research.** Future research should replicate this study as this is the first known study to use this type of teaching method and procedures to teach lipreading. Future research should also investigate factors promoting skill maintenance. It is possible that the use of rules and other self-management techniques to promote lip reading skills may increase generalization and maintenance. Additionally, researchers should systematically manipulate the length of time between the final training sessions and maintenance sessions as this may have influenced acquisition and maintenance. Finally, further investigation into the influence of age as a contributing factor to acquisition, maintenance, and generalization of lip reading and other functional skills
across age may provide additional insight into the best methods for designing instructional procedures for this demographic.

Most importantly, future studies should explore methods that will yield higher percentages of generalization. One way to do this may be to systematically arrange the training stimuli to include a wider range of sample visual signals. Recombinative generalization is a training method that has been successfully used to teach literacy skills to children and adults with disabilities (H. Goldstein, 1993; H. Goldstein & Mousetic, 1989; J. Goldstein, 1984; Romski & Ruder, 1984; Stiefel, Wetherby, & Karlan, 1976, 1978). This method involves training and recombining minimal linguistic units to produce accurate generalization to novel units (H. Goldstein, 1993). It is likely that a similar methodology would be effective for teaching lip reading and increasing generalization.
Chapter 5

Study 2

INTRODUCTION

The results from Study 1 demonstrated that a systematic approach to teaching lipreading was effective. In follow up response generalization and maintenance trials, little- to- no generalization of new untrained words occurred. This procedure may not have sufficiently trained a broad enough range of linguistic units to effectively produce such effects.

Recombinative generalization is the recognition of novel combinations of linguistic units that have been previously trained (H. Goldstein, 1993). Most research in this field has demonstrated the effects of recombinative generalization within the area of teaching literacy skills (H. Goldstein, 1993; H.Goldstein & Mousetic, 1989; J. Goldstein, 1984; Mueller, Olmi, Saunders, 2000; Romski & Ruder, 1984; Saunders, 2011; Saunders, O’Donnell, Vaidya, & Williams, 2003; Stiefel, Wetherby, & Karlan, 1976, 1978), and spelling (de Rose, J. C., de Souza, D. G., & Hanna, E. S.,1996; Hanna, E.S, de Souza, D.G., de Rose, J.C., & Fonseca, M., 2004, Hanna et. al, 2011). When learning to read, children typically recognize a word because of the previously learned linguistic units (letters and sounds) which are in the word. This is commonly known as “decoding” and is most often taught by teaching the sounds of each letter and blending the sounds into real words. This literature demonstrates that when individuals are taught to recognize and correctly respond to distinct units, they are also able to correctly respond to different combinations of the same units.
In an investigation of the behavioral process Skinner (1957) called “emergent recombination” within the use of a “miniature linguistic system” (MacWhinnery, 1983), Hanna et al. (2011) taught 55 literate college-age adults to read a pseudo-language comprised of disyllabic words. The researchers compared the learning of pseudo-words and generalization to novel pseudo-words as a function of the amount of training with new pseudo-words. Twelve training pseudo-words, each formed by two of four different possible syllables were presented and later recombined into novel pseudo-words during generalization testing. The results revealed that the higher number of trained relations that participants acquired, the better the participants’ ability to demonstrate generalization. In other words, as participants learned increasing numbers of recombinated pseudo-words, their accuracy similarly increased when exposed to new combinations of pseudo-words. Additionally, the researchers demonstrated that over exposure to a limited number (2) of pseudo-words which represented all syllables but in fixed positions was insufficient in producing generalization. This result suggested that the recombination was the critical factor in producing generalization.

Studies demonstrating recombinative generalization in linguistic fields such as reading and spelling suggest that it would be effective at producing generalization in other areas of verbal behavior as well, such as lipreading. Spoken words, identical to written words, are made up of smaller linguistic units. It is hypothesized that if smaller units such as syllables are trained, they could be combined, and recombinated to form novel words that could be recognizable without explicit teaching. This study utilized
the same training methodology as Study 1, but selected training stimuli that were systematically combined to assess their effect upon response generalization.
Chapter 6

METHOD

Participants, Setting, and Materials

Two college students ages 23 and 25 were recruited to be a part of this study. Participants reported that they did not have hearing loss and no hearing screening was performed. Participant’s eye sight was 20/20 either independent of corrective lenses, or with a corrective lens as reported by participants. Participants had normal speech production as informally determined by experimenter. Participants reported that they were able to read. Selected participants both stated that they did not have dementia or any psychological condition that would compromise the integrity of the study.

Individual sessions were conducted two times a week for 60 minutes per day in a quiet area of their home with minimal distractions. Participants were seated across a table approximately 3 feet from the experimenter. Materials present during sessions were 3”x5” cards with syllables printed in 48 pt font, with Times New Roman lettering. These cards made up the stimulus sets. The 5-syllable stimulus sets were used as textual prompts. Five sets of 5 syllables were used during Multiple Exemplar Training. Two sets of 5 words were created by combining the syllables for the purpose of assessing recombinative generalization. These word sets were used during baseline and post-tests.

Experimental Design

A multiple baseline design across participants was utilized in this study (Baer, Wolf, & Risley, 1968). This was done to compare the rate of acquisition across
participants. Multiple exemplar training was utilized to train syllables as described below.

*Dependent Variables*

The two dependent variables in this study were (a) number of blocks to criterion, and (b) percentage of words generalized. A correct response by the participant consisted of a vocal emission of the syllable mouthed (non-vocally) by the experimenter. An example of a correct response was if the experimenter presented the syllable “Mah” and the participant vocally responded, “Mah.” An example of an incorrect response was if the experimenter presented the target syllable and the participant responded with any other response than the target syllable. For example, if the examiner produced “Mah” and the participant vocally responded, “To.”

*Interobserver Agreement (IOA)*

IOA data was assessed by an independent observer during 38.1% of the sessions. An agreement was defined as the examiner and the observer both scoring a response as correct or incorrect. A disagreement was defined as the examiner scoring a response that differed from the response scored by the observer. Interobserver agreement was calculated on a trial-by-trial basis by dividing the number of agreements by the number of agreements plus disagreements within each block and multiplying by 100. IOA across both participants was 100%. Individual values for each participant can be seen in Table 1.
Table 1

*Interobserver Agreement (IOA)*

<table>
<thead>
<tr>
<th></th>
<th>Lindsey</th>
<th>Emmalee</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td># Blocks</td>
<td>50</td>
<td>55</td>
<td>105</td>
</tr>
<tr>
<td># Blocks with IOA</td>
<td>20</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>% Blocks with IOA</td>
<td>40</td>
<td>36</td>
<td>38.09</td>
</tr>
<tr>
<td>IOA</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Correct IOA Range</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Treatment Integrity*

Treatment integrity was assessed by an independent observer during 38.1% of the sessions. Antecedents and consequences were evaluated to ensure that they were given correctly in each trial presented by the examiner. A trial was scored as delivered correctly for antecedents if the examiner presented the correct target question specified on the data sheet in absence of voice, and presented the prompt with the appropriate time delay (if needed). Absence of voice was defined as the examiner mouthing a word with no audible sound serving as a prompt for the participant. A trial was scored as delivered incorrectly for the antecedent if the examiner presented a different target question than what was specified on the data sheet, if the examiner used their voice, or if the prompt was not given at the appropriate time delay. A trial was scored as correct for the consequence if the examiner delivered the reinforcer within two seconds of the participant emitting the correct response or if the participant was incorrect and the examiner delivered the correct error correction procedure. Treatment integrity was calculated on a block-by-block basis by dividing the number of agreements by the number
of agreements plus disagreements within each block and multiplying by 100%. Treatment integrity across both participants was 99.85%. Individual values for each participant can be seen in Table 2.

Table 2

<table>
<thead>
<tr>
<th>Treatment Integrity (T.I.)</th>
<th>Lindsey</th>
<th>Emmalee</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td># Blocks</td>
<td>50</td>
<td>55</td>
<td>105</td>
</tr>
<tr>
<td># Blocks T.I.</td>
<td>20</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>% Blocks T.I.</td>
<td>40</td>
<td>36</td>
<td>38.09</td>
</tr>
<tr>
<td>% Correct Antecedent</td>
<td>99.85</td>
<td>99.85</td>
<td>99.85</td>
</tr>
<tr>
<td>% Correct Consequence</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Correct Antecedent Range</td>
<td>97-100</td>
<td>97-100</td>
<td>97-100</td>
</tr>
<tr>
<td>Correct Consequence Range</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Procedures

Baseline. The purpose of the baseline condition was to ensure that any behavioral change was due to the effects of the training and recombination procedures used during later conditions. During baseline, syllable sets 1-5 and word sets 1 and 2 were randomly combined and probed by voicelessly mouthing the syllables and words, in absence of the prompting stimulus card. No programmed consequences were used during baseline. Each syllable and word was given three times in an unsystematic fashion. No stimulus items were presented more than one time in a row. If the participant responded by saying the correct word it was recorded as “correct.” If the
participant failed to respond or responded incorrectly the word was scored as “incorrect.” A homophenous word list that corresponded with each target stimulus was created to control for participant responses that matched the movement of the experimenter’s mouth but were not the target word. During baseline if the participant was given the target word and responded with a homophenous word the response was recorded as “H” and was not counted as correct or incorrect.

Training. Training was conducted to assess the effectiveness of prompts and reinforcement on the acquisition of target syllables. A progressive time delay procedure was implemented (Touchette, 1971) consisting of a 0 second, 3 second, and a final prompt phase consisting of no prompt as in Experiment 1. At the zero-second prompt delay, the experimenter presented the stimulus then immediately held up the prompt. The participant read the prompt aloud and their answer was scored as correct with prompting. At the 3s level, the experimenter presented the stimulus and counted three seconds before presenting the prompt. The participant could respond before the prompt was delivered. If they responded correctly the answer was marked as independently correct. If they responded incorrectly it was marked as incorrect, and if they waited for the prompt before responding their response was scored as correct with prompt. At the independent level, the experimenter presented the stimulus in absence of a prompt and the participant had five seconds to respond to the stimulus. If they responded correctly it was scored as independently correct, if they responded incorrectly the experimenter would re-present the stimulus with an immediate prompt. During the final phase, if no response was given within 5 seconds, the trial was scored as incorrect. Each syllable in
the 5-stimulus set was targeted three times in an unsystematic fashion, resulting in a 15-trial block. If the participant correctly responded to the target word, reinforcement in the form of non-descriptive social praise was provided. Mastery criteria were two consecutive blocks at 93% accuracy or better (14 of 15 trials correct) with respect to prompt level. Incorrect responses were consequated with an error correction procedure consisting of removal of any present materials, and immediately representing the target word with an immediate prompt (0 second delay). During training, if a participant responded with a homophenous word, it was not considered correct. It was recorded as “H” for homophene and the error correction procedure was implemented. If the participant responded incorrectly for three consecutive target words, the prompt delay was regressed to the previous level, and the participant had to again meet mastery criteria for two consecutive blocks to move to the next prompt level. Mastery criterion for each set was at least 93% accuracy (14 of 15 trials) for two consecutive blocks in the absence of prompts. Training was conducted until participants had learned all five sets. One vowel was isolated in each set so that the participant would learn that vowel and learn to discriminate between the consonants when they are followed by the same vowel ending. Table 3 shows syllable sets 1-5 that were trained.

Table 3

<table>
<thead>
<tr>
<th>Stimulus sets</th>
<th>Target vowel</th>
<th>Target syllable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set 1: /i/ as in “eee”</td>
<td>/mi, wi, ti, ki, fi/</td>
<td></td>
</tr>
<tr>
<td>Set 2: /a/ as in “aw”</td>
<td>/ma, wa, ta, ka, fa/</td>
<td></td>
</tr>
<tr>
<td>Set 3: /u/ as in “ooo”</td>
<td>/mu, wu, tu, ku, fu/</td>
<td></td>
</tr>
<tr>
<td>Set 4: /o/ as in “oh”</td>
<td>/mo, wo, to, ko, fo/</td>
<td></td>
</tr>
<tr>
<td>Set 5: /5/ as in “er”</td>
<td>/mer, wer, ter, ker, fer/</td>
<td></td>
</tr>
</tbody>
</table>
Following training, the experimenter mixed the sets so that vowel endings were balanced across the sets, with no set containing more than one of the same vowels. The purpose of the mixed training condition was to train the participants to identify the syllables outside of their original sets. Each mixed set consisted of five different vowel sounds and five different consonants. Table 4 shows mixed sets 1-5. Mastery criteria was 93% accuracy or better for each set. Once criterion was met the mixed training condition was complete.

Table 4

<table>
<thead>
<tr>
<th>Mixed stimulus sets</th>
<th>Set 1</th>
<th>Set 2</th>
<th>Set 3</th>
<th>Set 4</th>
<th>Set 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>/mi/</td>
<td>/wi/</td>
<td>/ti/</td>
<td>/ki/</td>
<td>/fi/</td>
<td></td>
</tr>
<tr>
<td>/we/</td>
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<td>/fe/</td>
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<td>/fer/</td>
<td>/mer/</td>
<td>/wer/</td>
<td>/tet/</td>
<td>/ker/</td>
<td></td>
</tr>
</tbody>
</table>

Post-test. Post-tests were conducted identically to pre-tests except only whole words, and not syllables, were assessed. The purpose of the post-test was to assess participants’ identification of untrained, novel words, made from the combination of the trained syllables. Table 5 represents the two sets of novel words made from the syllables. Post-testing was conducted following mastery of the mixed training sets. Criterion for passing post-test was 93% accuracy or better. If participant met criterion for each set, the study was complete. If performance did not meet criterion during post-testing the mixed training sets were taught again and the post-test followed the mixed training once criterion was met.
Table 5

Post-test stimulus sets

<table>
<thead>
<tr>
<th>Word Set 1</th>
<th>Water, Murky, Tofu, Chemo, Coffee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word Set 2</td>
<td>Tommy, Motor, Photo, Femur, Turkey</td>
</tr>
</tbody>
</table>

Maintenance Probes. Maintenance probes were conducted to assess whether the target syllables learned during the study and generalization words maintained following completion of the study. Probes were conducted six weeks following the completion of the study for each participant. Maintenance probes consisted of each generalization word presented in a 15-trial block with four other generalization words (see Appendix A for sample data sheet).
Chapter 7

RESULTS

Figure 1 shows the percentage of independent correct responses across 15-trial blocks for Lindsey and Emmalee during baseline, training, post-testing, and maintenance conditions. Baseline sessions were conducted once for Lindsey and twice for Emmalee. Baseline consisted of 2 sets of real words and 5 sets of syllables. Each set was presented in a 15-trial block. Solid squares indicate correct vocal responses emitted during baseline and post-test conditions for word sets. Solid circles indicate correct vocal responses emitted during baseline for syllable sets. Solid triangles indicate correct vocal responses in the absence of prompts during training. Solid diamonds represent the correct vocal responses in the absence of prompts during the mixed set training, and the gray X’s indicate the vocal emission of a homophenous word for the target word during baseline, training, or post-testing conditions. Termination criterion was met during the second post-testing condition for both participants. Maintenance probes were conducted 6 weeks following each participant completing their second post test. Both participants demonstrated significant response maintenance.

During Lindsey’s baseline session for word set 1 she was 26% accurate producing 3/15 target words and 1/15 homophenous words. During word set 2 she was 26% accurate, producing 2/15 target words and 2/15 homophenes. Percentages of accuracy during baseline are as follows for syllable sets 1-5 respectively: 26% correct - 1/15 target words and 3/15 homophemes, 13% correct – 1/15 target words and 1/15
homophones, 20% correct – 0/15 target words and 3/15 homophones, 26% correct 1/15 target words and 3/15 homophones, and 13% correct – 0/15 target words and 2/15 homophones. During the training condition for syllable set 1, Lindsey answered correctly during 14 out of 15 trials or better in the absence of prompts for 2 consecutive blocks in 7 blocks. Lindsey met mastery criteria for training of syllable sets 2 through 5 in 4 blocks each. During the first mixed syllable set training, Lindsey answered correctly during 14 out of 15 trials or better in the absence of prompts for all 5 sets in 7 blocks. During her first post-test condition for word set 1, Lindsey correctly produced 60% (9/15 trials) of the target words and no homophones. For word set 2 she was 80% correct, producing 10/15 target words and 2/15 homophones. During the second mixed training condition she met mastery criterion in 7 sets. In her second post test condition for word set 1 she was 93% accurate (14/15 trials) producing all target words and no homophones. For word set 2 she was 100% accurate producing 14/15 target words and 1/15 homophenous words. During maintenance probes for word set 1, Lindsey was 86% accurate producing 12/15 target words and 1/15 homophenous words. For word set 2 she was 100% accurate producing 15/15 target words.

During Emmalee’s first baseline session for word set 1 she was 33% accurate producing 5/15 target words and no homophenous words. During word set 2 she was 26% accurate, producing 4/15 target words and no homophenous words. Percentages of accuracy during baseline #1 are as follows for syllable sets 1-5 respectively: 40% correct -2/15 target words and 4/15 homophones, 73% correct – 7/15 target words and 4/15 homophones, 40% correct – 1/15 target words and 5/15 homophones, 46% correct
- 3/15 target words and 4/15 homophones, and 40% correct – 5/15 target words and 1/15 homophones. In her second baseline session for word set 1 she was 40% accurate producing the 4/15 target words and 2/15 homophenous words. During word set 2 she was 20% accurate, producing 1/15 target words and 2/15 homophenous words. Percentages of accuracy during baseline #2 are as follows for syllable sets 1-5 respectively: 53% correct - 3/15 target words and 5/15 homophenes, 73% correct – 5/15 target words and 6/15 homophenes, 40% correct – 2/15 target words and 4/15 homophenes, 33% correct - 3/15 target words and 2/15 homophenes, and 53% correct – 5/15 target words and 3/15 homophenes. During the training condition for syllable sets 1 through 5, Emmalee answered correctly during 14 out of 15 trials or better in the absence of prompts for 2 consecutive blocks in 4 blocks each. During the first mixed syllable set training, Emmalee answered correctly during 14 out of 15 trials or better in the absence of prompts for all 5 sets in 7 blocks. During her first post-test condition for word set 1, Emmalee was 93% correct producing 9/15 target words and 5/15 homophenes. For word set 2 she was 73% correct, producing 9/15 target words and 2/15 homophenes. During the second mixed training condition she met mastery criterion in 8 sets. In her second post test condition for word set 1 she was 100% accurate producing 12/15 target words and 3/15 homophenes. For word set 2 she was 100% accurate producing 11/15 target words and 4/15 homophenous words. During maintenance probes for word set 1, Emmalee was 93% accurate producing 9/15 target words and 5/15 homophenous words. For word set 2 she was 100% accurate producing 11/15 target words and 4/15 homophenous words.
Figure 1. Block-by-block acquisition data – Lindsey and Emmalee. Percentage of independent correct responses per block for Lindsey and Emmalee. Solid squares represent baseline responding for whole words, solid circles represent baseline responding for syllables, gray X’s represent homophenous words for target responses, solid triangles represent responses taught during training condition, solid diamonds represent responses during mixed training, open squares represent responses emitted during post testing, and open triangles represent maintenance probes.
Chapter 8

DISCUSSION

The results obtained in the current study suggest a promising methodology to promote the acquisition, response maintenance, and response generalization of lip reading skills. Both participants in this study demonstrated rapid acquisition of target linguistic units. The results of Emmalee and Lindsey’s maintenance probes also revealed high levels of durability following a six-week gap in training. Most importantly, the use of unit recombination yielded high percentages of generalization to untrained linguistic unit combinations for both participants.

The results from Study 2 replicate the findings from Study 1 in showing the effectiveness of systematic lip reading training when taught using prompting and reinforcement. Both participants again rapidly learned all target stimuli and made limited errors during training. These results suggest a preferred method for teaching lip reading.

The methodology used in this study was specifically employed to yield higher rates of generalization, and thus better social validity, than in Study 1. By training a selection of minimal response units, both participants demonstrated significant amounts of response generalization when presented with novel combinations of these minimal units. Alessi (1987) referred to selections of minimal stimulus-response sets as the “generative set” and the set of possible novel combinations of these minimal responses units as the “universal set”. He notes that a careful selection of unit members taught within the generative set will then yeild multiplicative power to the number of
novel words that would then be recognizable in the universal set through combining and recombining elements of trained minimal units. In the current study, all trained units were later readily readable during generalization tests when presented in combinations to form new words. Because the critical element producing the response generalization into new word combinations appears to be the degree to which the participants accurately respond to the minimal units, it is possible that many more combinations of the trained units would also have been recognizable to the participants.

The systematic selection of training stimuli to enhance the development of response generalization lies at the heart of recombinative generalization approaches. Although the empirical demonstration of successful generalization outcomes using this strategy has begun to receive increased attention (H. Goldstein, 1993; H. Goldstein & Mousetic, 1989; J. Goldstein, 1984; Mueller, Olmi, Saunders, 2000; Romski & Ruder, 1984; Saunders, 2011; Saunders, O’Donnell, Vaidya, & Williams, 2003; Stiefel, Wetherby, & Karlan, 1976, 1978), Stokes and Bear (1977) suggested the basis for this approach years earlier. Stokes and Bear (1977) recommend teaching “the full range of relevant stimulus conditions and response requirements” as a strategy for promoting generalization when teaching skills. The results of the current study suggest furthermore that the benefits of this strategy also apply when teaching lip reading.

The failure to produce both response maintenance and response generalization in Study 1 is likely attributable to a failure to include a careful selection of relevant stimulus conditions. The major difference between the procedures used in Study 1 and Study 2 is the added attention given to the training stimuli that were included.
Although the degree of visibility among training stimuli included in Study 1 were controlled for, this is now clearly less important than the degree to which they are similar to the response requirements for the testing stimuli.

The current procedures’ effects upon the influence of response maintenance are still in question. One explanation could be that the young age of the participants influenced their retention compared with the older participants that were included in the first study. Another explanation may be that the minimal units that were taught throughout training sessions were more likely to be contacted outside of training sessions. Recognition of these units during everyday speech-interactions may have inadvertently created additional learning opportunities between the end of training and follow up testing. Additionally, response maintenance and response generalization could be related so that the same reasons response generalization was produced could be the same reasons response maintenance was observed.

The results of both Study 1 and Study 2 have implications for the application of aural rehabilitation and lip reading. First, the systematic use prompts and reinforcement may influence more rapid learning during teaching sessions. Related to the increased speed in learning is also the limitation upon errors made during training. Although not directly assessed, we could assume that clients would report more satisfaction in participating in training sessions where successful learning opportunities far outnumber errors made. Secondly, the results suggest implications for the debate between analytic or synthetic approaches to teaching lip reading. These results suggest that neither method is necessarily a better method over the other but rather they each may be
necessary, but in a specific order. The utility of teaching minimal units to maximize generalization to novel words is in line with analytic approaches to teaching lip reading. A goal for any teaching procedure should be minimizing the number of required training sessions while maximizing its generality to new examples. This is especially true for the traditional demographic receiving aural rehabilitation therapies. Costs for hearing health care and the limited longevity in which therapeutic outcomes may be used make this an even more important endeavor.

An efficient and effective method to teach enough minimal linguistic units is likely insufficient for a functionally robust lip reading skill set. Due to the limitations among uniquely distinguishable linguistic units in the English language, the use of a more synthetically based teaching strategy following analytic training may be required. In both studies, participants often produced homophenous words in place of the target word. In order to functionally distinguish between words that lip readers recognize and what the speaker is actually saying, the context in which it is used becomes critical. With a sufficient foundation of readily recognizable minimal linguistic units, a learner should be much better equipped to identify words in a speakers’ sentence. Subsequently, synthetic methods teaching comprehension through context may be more efficient.

Limitations. One limitation of the study is the age of the participants. Both participants were college-age and not similar in age to the demographic that would typically be receiving aural rehabilitation therapy. Age has been shown to be related to skill acquisition and retention and differences in the results of maintenance measures
could be due to this (Arnold, 1997; Feld & Sommers, 2009). However, there were significantly greater rates of generalization during this study compared to the first. This is not likely due to the age difference, but because of the teaching procedure because both response maintenance and response generalization outcomes were similarly affected. Additionally, some of the participants from Study 1 had very similar rates of acquisition and in some cases faster, as the younger participants in Study 2 during the training phases. Future studies should employ the use of recombinative generalization with participants whose demographic variables more closely represent those of individuals in need of, or receiving, aural rehabilitation therapy.

Another potential limitation was the failure to include important additional training variables to further train for and test generalization. Stokes and Baer (1977) recommended techniques for training for and assessing generalization. In their article they recommend planning for setting and/or situational generalization. The current study included the use of only one trainer and conducted training in a specific location throughout all phases of the study. Because of this, we can only say that this procedure produced generalization to new words, but may not generalize to novel speakers or in different settings. Particularly in naturalistic settings, each speaker’s unique articulation and rate of speech could affect the accuracy of a listener’s comprehension. Similarly, situational and environmental factors could significantly affect performance in lipreading. Differences in an environment’s noise level, brightness, number of people, etc. could all negatively affect performance. Finally, the small number of participants was a limitation to this study. Additional studies should also include a larger sample.
Future research should include measures to train and assess for setting and situational levels of generalization.

In summary, both studies demonstrated the positive effects of using a systematic training approach to teach lipreading. All seven participants across both studies quickly learned all target words using a systematic prompt and reinforcement/error-correction procedure. These results confirm the assertion that lip reading skills can be taught to a variety of individuals. Furthermore, the results highlight the importance of carefully selecting training stimuli that sample a sufficient range of phonemes to generate novel responding.
REFERENCES


