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/INTƐLI/ A BILINGUAL COMPUTER SOFTWARE TREATMENT PROGRAM FOR APRAXIA OF SPEECH

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by

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THESIS

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Abstract

Apraxia of Speech (AOS) is a motor speech disorder characterized as difficulty planning and producing precise and refined movements of the articulators for intelligible speech (CASANA). **Purpose:** The purpose of this study was to explore the success of /Intɛli/, an experimental computer program that incorporates melodic intonation therapy (MIT), modified eight step continuum, visual and auditory cues, and voice recordings for instant feedback to increase speech intelligibility. **Method:** A single subject multiple-baseline design was used to examine the effects of /Intɛli/ on the speech intelligibility of a child diagnosed with severe AOS. Treatment was applied to 30 multisyllabic words in random order using /Intɛli/. **Results:** The participant demonstrated improvement in her speech intelligibility with the practiced words.

Keywords: Apraxia of speech, speech intelligibility, technology

Table of Contents

List of Tables

List of Figures

CHAPTER 1: INTRODUCTION

In the health profession diagnostic labels are useful for prognosis and treatment planning. Apraxia of Speech is a diagnostic label which is commonly used, yet controversial (Bowen, (1998). There is much debate on the proper terminology, characteristics, and treatment for apraxia (Finlay, 2009). Childhood apraxia of speech (CAS) versus developmental apraxia of speech (DAS) versus acquired apraxia of speech, are all distinct terms according to the American Speech-Language Hearing Association (2007). Developmental apraxia of speech has a positive connotation in addressing the idea that a child will eventually "grow out of" the disorder, whereas the term childhood apraxia of speech is preferred because it implies presence of a speech sound disorder (ASHA 2007). The behaviors are noted to be the same, but the connotation that the labels carry is different. Childhood apraxia of speech is being pushed to become a universal term and replace the use of DAS (ASHA 2007). Acquired apraxia of speech is a label applied to adults. According to Masseen (2002) and ASHA (2007) one of the fundamental differences is that motor speech impairment has an impact on the acquisition of "higher phonological and linguistic processing levels" (p. 3). Even though the literature and research in this area/field suggests differences between these labels; for the purposes of this study, the term apraxia of speech (AOS) will be used interchangeably with CAS and DAS, because the presented participant is 13 years old.

Defining Apraxia of Speech

Discrepancies on the definition of AOS appear across the board in terms of the definitive characteristics of this disorder. Forrest (2003) suggests that ambiguity exists amongst practicing Speech Language Pathologists in giving concrete characteristics of this disorder. Forrest (2003)

reported a frequency of characteristics to define AOS, to include; inconsistent productions, general oral-motor difficulties, and groping. Rosenbek, Hansen, Baughman, & Lemme (1974), Yoss & Darley (1974), Davis (1998) and ASHA (2007), commonly report that 'motor programming problems' are the distinguishing factor in AOS. However, Forrest's (2003) reports indicated that most Speech-Language Pathologists (SLPs) agree that the distinguishing characteristic of AOS is inconsistent speech productions. Forrest does acknowledge that although 'inconsistency' was reported to describe AOS, there is no further explanation on what kind, where, or how the inconsistency appears in AOS.

Inconsistency of productions is consistent with reports by Davis, Jackielski, and Marquardt (1998). These researchers report that occurrence of AOS is marked by variability and lack of consistent patterns of speech output for both consonants and vowels, which can occur in the repeated production of the same lexical item (the same word). Davis et al. (1998) listed other behavioral and speech and language characteristics that are consistent with other researchers' definitions; namely, speech production characteristics such as restricted consonant and vowel inventory, lack of consistent productions of mistarticulations, severe reduction in speech intelligibility, and unsteady pitch. Language characteristics include: age-appropriate receptive language and significantly less expressive skills and errors in syntax and morphology. According to Rosenbek et al. (1974), AOS is not a language disorder but it might coexist with "language deficits and learning disabilities" (p. 13). Yoss and Darley (1974), define the characteristics of apraxia as, "the failure or limited ability to control and direct the movements" (p. 23) and similarly Rosenbek et al. (1974) described the characteristics as, "impaired ability to accomplish" (p. 13). For the present study we used the ASHA (2007) definition of AOS, a neurological childhood speech sound disorder where there is an inconsistency of precision of

movements in the oral mechanism, in the absence of any neuromuscular deficits (eg. Abnormal muscle tone) the core impairment in planning and/or programming of movement sequences resulting in errors in speech sound production and prosody. These errors in speech sound production are attributed to the individual's decreased speech intelligibility, as stated by Davis et al. (1998).

Treatment Approaches

There has been a wide range of treatment approaches towards improving speech intelligibility of people with AOS. A summary of treatments for AOS were presented by Pannbacker (1988) and Wambaugh (2002). The techniques included were singing, adapted cueing, movement sequencing, systematic drill, melodic intonation therapy, electromagnetic articulographic feedback, signed target phonemes, and the use of total communication. The goal of treatment in general terms is to improve the individual's ability to assemble, retrieve and execute motor plans for speech (Yorkston, Beukelman, Strand, & Hakel, 2010). Movement pattern is a prominent aspect of treatment that is designed to improve motor skills as well as the use of decreased rate, proprioceptive monitoring, and the pairing of movement sequences with suprasegmental facilitators according to Yorkston et al. (2010). Regarding the current study /Intɛli/ incorporated melodic intonation, auditory and visual cueing, the application of portions of the modified eight-step continuum by Deal & Florance (1978), and the use of Praat software program to aid in the improvement of speech intelligibility.

Melodic Intonation Therapy (MIT)

The researchers Albert, Sparks, and Helm first introduced melodic intonation therapy (MIT) in 1973 to aid severely aphasic adults with encoding thoughts into meaningful verbal communication (Laughlin, Naeser, and Gordon, 1979; Norton, Zipse, Marachina, & Schlaug, 2009). The rationale for MIT is based on a hypothesis that the damaged left hemisphere (language dominant) is aided, and stimulated through the use of intonation (consisting of rhythm, stress, and melodic contours) by the undamaged right hemisphere (Krauss & Galloway, 1982; Yorkston et al., 2010). MIT is accomplished by using musical elements of speech, which are melody and rhythm, to enhance expressive language by focusing on preserved functions, such as singing, to engage language capable regions of the undamaged right hemisphere (Norton et al, 2009). Engaging those undamaged regions of the right hemisphere is facilitated by MIT through a set of hierarchical structured procedures.

There are five steps to the execution of MIT, as reported and summarized by Laughlin et al. (1979) and Norton et al. (2009). The five steps are (1) humming in which the phrase is introduced with a visual cue, at a rate of one syllable per second, while tapping the patient's left hand one time per syllable; (2) Unison intoning in which the patient and clinician sing the phrase while the clinician taps the patient's left hand (one time per syllable); (3) Unison intoning with fading in which the clinician and patient continue to sing and tap together, then halfway the clinician fades while patient continues to sing the rest of the phrase accompanied by hand-tapping; (4) Immediate repetition in which the patient repeats the intoned (sung) production by themselves; (5) The patient sings the appropriate response to the clinician's intoned question.

This treatment was then implemented, not only for aiding in language but also for improving articulation to reduce the occurrence rate of phonemic errors. There is more literature

supporting the effectiveness of MIT treatment with Broca's aphasia patients than AOS. However, the studies that are available have shown MIT to be effective with AOS patients, since one of the characteristics is errors in articulation (Norton et al., 2009). Martikainen and Korpilahti (2011) reported an increase of sequencing abilities and a decrease in speech sound errors of a four year seven month old child after six weeks of MIT. Krauss and Galloway (1982) reported significant gains in articulation skills as well as gains in verbal naming, phrase length response and verbal imitation tasks with two children, who served as their own controls, receiving traditional therapy with MIT.

Auditory & Visual cueing

Auditory and visual input is a common method used to improve speech production for people diagnosed with moderate or severe AOS (Yorkson et al., 2010). It is an imitative method that emphasizes multiple input modes composed of auditory and visual cueing, which permits the drilling of target stimuli to be efficient and straightforward. The use of visual modality increases the adequacy of the target sound or sequence (Rosenbek et al., 1974). This is accomplished by clinician using the phrase; "watch me and listen to me" then providing the visual and auditory model (Yorkson et al., 2010). The focus of this treatment approach is on the individual's oral movement patterns and the goal is adequate speech signals (Yorkson et al., 2010).

According to Wertz, LaPointe, and Rosenbek (1991), the emphasis is not only on lingual movements but also requires drilling and intensive repetition of selected responses. These selected responses should be based on the individuals' severity of apraxia. Rosenbek et al. (1974) state that words and phrases are appropriate stimuli for children diagnosed as having mild AOS. The researchers' reasoning is that children with mild AOS may manifest only slight

articulation errors as well as prosodic abnormalities. Severe AOS is also addressed and their therapy should emphasize movement sequences in consonant vowel (CV) and vowel consonant (VC) syllables rather than sounds in isolation, these children may only use a few speech sounds in single syllables or in reduplicating utterances.

Rosenbek, Lemme, Ahern, Harris, and Wertz (1973) presented four main therapy principles for AOS that should be considered: (1) Integral stimulation ("Listen to me and watch me") should be tried first, and effective: (2) As therapy progresses and the individual produces volitional, non-imitative speech, auditory then visual cues should gradually fade; (3) Visual memory of correct production should be emphasized and developed upon the first day. The use of a mirror and written words might be useful; (4) When the integral stimulation method has failed with the individual or with a particular speech sound, the clinician should move to other methods.

These principles of integral stimulation and complexity are incorporated into the treatment methodology of the Eight-Step Continuum by Rosenbek et al. (1973). A summary of the eight-step continuum is presented by Table 1.

Table 1.1: Eight-Step Continuum

Continuum Steps	**Cues**
1. Integral Stimulation	Visual & Auditory cues simultaneously
2. Integral Stimulation	Visual & Auditory cues w/a delay, clinician mimes
3. Integral Stimulation w/a delay	Clinician verbalizes & client produces stimulus after. No other cues
4. Successive production w/no visual or auditory cues	Clinician produces utterance & client produces utterance consecutively several times
5. Written stimulus & simultaneous production	Reads the target utterance
6. Written stimulus w/delayed production	Reads utterance and produced when it has been removed
7. Appropriate response (uses question)	Patient responds w/target utterance, elicited by appropriate question
8. Role playing response	Appropriate roles to target utterance & client response appropriately

The Eight-Step Continuum was investigated by Deal and Florance (1979) and it was concluded that it was not necessary to progress systematically through all eight steps of the program. According to this study by Deal and Florance (1979), the participants only needed to precede from step one through step four for the target utterance to be established. Rosenbek et al. (1973) came to similar conclusions, that systematic progress is not necessary due to his participant's demonstrating difficulty at step 4, so the steps became altered and individualized. Rosenbek et al. (1973) also suggested increasing the drilling at earlier steps or establishing a rigorous criterion, would override the difficulty, at step 4. Deal and Florance (1979) incorporated both suggestions in their study, setting the criterion to 80% with a total of 150 correct productions for each step and reported speech improvement with their participants.

Backward Buildups

Velleman (2004), introduced the concept of backward buildups as a strategy to improve prosody in multisyllabic words with individuals diagnosed with CAS. It consists of natural prosody being learned, by starting at the end of a word or sentence and working forward. In the English language, prosody is primarily affected by the occurrence of the end of a word, phrase, or sentence. An example of this occurrence is adding an ending to a word which then changes the stress pattern; "the stress in the word "eLECtric" shifts from "lec" to "tri" when "ity" is added to the end: "ElecTRIcity" (Velleman, S., 2004 p.1). Children diagnosed with childhood apraxia of speech are at risk for prosodic problems as well as demonstrating difficulty with longer and more complex utterances. This method might be helpful in aiding with increasing their speech intelligibility.

Feedback

Feedback is an important component in the treatment of individuals with AOS. It is a tool that may assist in the improvement of motor skills in speech through conditions such as types of practice and schedules of feedback (Yorkston et al., 2010). Motor learning is referred to as a "set of internal processes associated with practice or experience leading to relatively permanent changes in the capability for movement" (Schmidt & Lee, 2005, p. 302). The relationship between refining and strengthening through experience is how learning occurs, derived from the schema theory by (Schmidt,1975, as cited in Austermann Hula, Robin, Maas, Ballard, & Schmidt, 2008). Therefore predictions could be made on how the new skills will be learned by the conditions during practice and the type of external or augmented feedback (Austermann Hula et al., 2008). The effectiveness between reduced and delayed feedback has

been reported as dependent upon the individual and in the study reported by Austermann Hula et al. (2008), benefits of learning occurred with both types of provided feedback.

The treatment strategies mentioned above relate to those which do not use technology. The remaining treatments which will be discussed are those which make use of technology as in software programs for either articulation disorders, or AOS specifically.

Software to Treat Articulation

The bottom-up approach is a treatment option for clinicians when treating individuals with AOS. Teaching and drilling the distinctive features for each phoneme in the appropriate language. The following commercially available English online articulation computer software programs were reviewed: *Articulation I. Consonant Phonemes, PocketSLP Articulation, Pronunciation Patterns, and Video Voice Speech Training System.*

Articulation I. Consonant Phonemes offers several features to aid the individual in producing 20 consonant phonemes in the initial, medial and final word positions. The individual has options to choose from stimuli consisting of words, sounds, phrases, sentences, and exaggeration to hear and see target phoneme. These response options are aided through the use of visuals consisting of pictures and written words; audio addresses phoneme and words, and provides audio feedback through the use of recordings, replays the individual's production. This program targets therapy for Oral Apraxia, Dysarthria, and Developmental Speech Disorders.

Specifically for a client with AOS, the program does not offer visual modeling of the target consonant via articulator movements, where imitation facilitates drilling of appropriate articulator's placement. It also focuses on target sounds in monosyllabic words (via demo) not addressing sounds in multisyllabic words, which has been noted that individuals with AOS

experience breakdown. Lastly, there is no way of saving the voice productions of the individual to compare throughout time and track improvement.

PocketSLP: Articulation Therapy is an application that may be downloaded by iphones, ipads, and droids to aid clinicians in therapy. The application provides an array of functions to assist the individual. For example, the application includes target phonemes in all word positions, it provides pictures that represent the target word or sentence, a sagittal and palatal view of lingual placement is made available which produces specific phonemes with the option of hearing the phoneme, auditory feedback is included which indicates if production were correct, incorrect, or approximate and the application collects data in real time which may be emailed.

The application does not offer visual movements of articulators to produce target phoneme, word or sentence; which is important for individuals with AOS in facilitating successful imitation. Word complexity is not systematically addressed. The application randomly presents the individual with monosyllabic, bisyllabic, or multisyllabic words. As noted previously, individuals with AOS demonstrate inconsistent productions and breakdowns with multisyllabic words so they may benefit from systematic complexity. The program only offers two levels, word and sentence, offering no transition taking place between those levels, such as phrase level. Individuals may benefit from enhancing the auditory feedback from just an incorrect, correct or approximate sound to hearing their own production of the target word or sentence and comparing it to the presented production.

Pronunciation Patterns asserts usefulness for learning and improving American pronunciation, the American accent, vocabulary, improving fluency, and helping children with phonics. According to the website, this is accomplished through the presentation of the 44

Standard English phonemes, online mouthed video clips and animations for vowels and consonants, using American Psychological Association (APA) and International Phonetic Alphabet (IPA) symbols with over 100 phonics and pronunciation rules to improve English pronunciation, and over 4,000 words with real person pronunciation. The website also states that speech recognition will act as the instructor to help the user correct their word pronunciation, which can be recorded and played back in a waveform diagram, the speed of words may be altered, any text could be read to the individual, it contains a color scheme to stimulate the mind, as well as 1,000 audio sentences, and has online accent tips/lessons.

All of the functions of the program are useful because it incorporates visuals, auditory stimulation, and provides feedback to increase the individual's articulation. However, the program only displays visuals for the 44 English phonemes and does not show the production of phonemes in syllables or words. This lack of hierarchy does not address the different contextual complexities in which visual and auditory modeling could aid individuals in articulating phonemes successfully and appropriately at different levels. The program provides an ample number of tools that could be useful in aiding individuals to appropriate articulation of phonemes, words, and sentences. However, this program lacks a form of immediate feedback for incorrect productions, leaving individuals to interpret results. An example of immediate feedback would be a verbal cue at the moment from a professional, such as a speech-language pathologist; or in terms of the program displaying the waveform diagrams (individuals production and the correct form) highlighting the incorrect production in real time.

Video Voice Speech Training System is a treatment tool for speech-language pathologists that target a variety of speech components. In regards to targeting articulation improvement the program suggests using formant displays, P-A-R (pitch, amplitude, rhythm) displays and

incorporating games. All mentioned displays allow for personalized adjustments according to target goals. These adjustments may include specific target vowels or words via clinician's voice recordings, requiring an individual to match the clinicians' verbal recording. An individual's production is captured in real time and compared to the original model providing visual and auditory feedback through the formant matrix.

The flexibility given to clinicians in adjusting target stimuli within the program is beneficial for the participating individual and clinician. This is due to the fact that visual and auditory feedback is provided for the specific stimuli and allowing for analysis of production. However, the client may benefit from further visuals, such as articulation placement for original production. The program displays an orthographic representation of target phonemes, however, moving the orthographic representation to the top of the window may assist the individual with increasing the appropriate target production.

Apraxia of Speech Software Programs

The Speech-EZ® Apraxia Program is an iPad application that is soon to be released. No demo is available as of this writing. However the website for the application (www.speech-ez.com) provided much information on the application. The application has been designed to provide clinicians with multisensory strategies needed to improve speech intelligibility with children diagnosed with Childhood Apraxia of Speech (CAS) and severe Developmental Phonological Disorders. The strategies consist of "visual, auditory, proprioceptive, gestural and tactile input in order to teach the child the correct movement sequences for speech" (Carahaly, L. p.1).

It appears that the application consists of targeting phonemes and words with different syllable structures. It contains over 775 colorful pictures with a variety of syllable structure options, for example, CVC or CVCV. It is not stated whether those target words carryover into functional and meaningful phrases or sentences. The production of the articulators is not shown within the same display for target stimuli; it appears that it is located in one of the subprograms, called, "Hand Cue Cards" (Carahaly, L p.2). Providing the visual production of the articulators within the same display screen as the target syllable structure would provide further scaffolding for targeting appropriate verbal output.

Bungalow Software (Articulation, Apraxia) has a total of 22 programs categorized by symptom, reported to be effective in clinical and home settings with patients following stroke or brain injuries. The programs suggest improvement of articulation and consists of the following programs: "Speech sounds on cue", "Sights 'n sounds 1" (available in Spanish), "Sights n' sounds 2", and "SpeechPacer". The program follows a systematic hierarchy that begins with the use of multimedia videos for visual and auditory modeling of 19 consonant phonemes contained in the "Sound on Cue" CD. The "Sights 'n sounds 1 & 2" program increase the level of complexity by first targeting words (CD 1), then sentences (CD 2), and by altering the feedback from videos to a comparison of the model sentence with the individual's verbal production. At any level if the rate of verbal production is noted to be slow or fast then, "SpeechPacer" may be used to pace the individual's verbal production through automatic or manual cursor/text advancement.

In regards to the structure of the program, the levels of complexity will continue to challenge the individual in a systematic manner leading to appropriate articulation in spontaneous speech. On the other hand, the content of the program does not build upon each

other from one CD to another. For example, the target words in "Sights 'n sounds 1" are not transitioned in "Sights 'n sounds 2" at the sentence level. In order, to establish a consistent behavior of the target word, drilling should be targeted at all levels of complexity to allow for functionality and generalization to occur.

Table 1.2. Articulation Software Program Summaries

Articulation software	**Hierarchy**	**Feedback**	**Languages**	**Website**
Articulation I. Consonant Phonemes	Target phoneme presented in word, sound, phrase, sentence, and exaggerated	Voice recordings, not stored, but may be replayed.	English Spanish (only for ages 3-8)	www.locutour.com
PocketSLP Articulation	Target phoneme presented at word &/or sentence level	Auditory: correct, incorrect & approximations	English	www.pocketslp.com
Pronunciation Patterns	No set hierarchy with word length or complexity, individual may choose	Voice recognition, replay production, wave diagram, video of phoneme production	English	www.pronunciation-patterns.com
Video Voice Speech Training System	Dependent upon clinician	Formant displays	English, Localization and Support for Multiple Language Keyboards	www.videovoice.com

Table 1.3. Apraxia of Speech Software Summaries

Apraxia of Speech Software	**Hierarchy**	**Feedback**	**Languages**	**Website**
Speech-EZ® Apraxia Program	Increase in syllables, word	Touch cueing	English	www.speech-ez.com
Bungalow Software (Articulation, Apraxia)	Phoneme, word, sentence	Voice recording (replayed)	English "Sights 'n sounds 1" is also in Spanish	www.bungalow-software.com

Experimental software- /Intɛli/

/Intɛli/ is a software program containing similar features as previously discussed programs in that it provides a visual picture to represent the target stimulus, and a systematic hierarchy (syllable/word, phrase, and sentence), the comparison of recorded target model to the individual's verbal production, and the integration of multimedia video recordings.

What distinguishes /Intɛli/ from other programs: (1) interchangeable bilingual screens; (2) is how the features are presented and applied; (3) flexibility with the direction of drilling multisyllabic words; (4) a structured integration of the modified eight step continuum and Melodic Intonation Therapy (MIT) (5) and a systematic method of providing feedback.

The program may change from English (American flag) to Spanish (Mexican flag) and vice versa with the click of a button. The changes between the languages occur within the same window maintaining the same layout, and the features adjust to the corresponding language.

One of the features that /Intɛli/ provides is the syllable breakdown for each of the presented multisyllabic words. Video-audio recordings have been provided for each target multisyllabic word and corresponding syllables at the word level. Phrase and sentence levels are

provided with video-audio recordings for all presented words including target words. This allows flexibility to take place with the order and number of syllables exposed (flipping all the syllables at once or individually) at the word level, and control of the word exposure at the phrase and sentence level. The expansion and reduction of syllables and words permits for individualized drilling to occur of target stimuli. The continuous reinforcement and drilling allows for functionality and generalization of targeted multisyllabic words to happen.

Since the multisyllabic words are broken down into syllables, the direction of drilling may be chosen. The strategy of backward buildups could be applied in therapy session targeting prosody and having some effect on speech intelligibility. As mentioned earlier, this strategy begins with the last syllable in English being drilled and each syllable thereof, proceeding forward.

The drilling of stimuli continues to be reinforced, by encompassing three of the main principles of the Eight-Step Continuum: (1) Integral stimulation (2) As the individual produces volitional, non-imitative speech, auditory then visual cues should gradually fade and (3) Visual memory of correct production should be emphasized and developed on the first day.

The concept of integral stimulation, "Listen to me and watch me" is incorporated by the use of video-audio recordings for each syllable, word, phrase and sentence. All target multisyllabic words are written out and a visual picture of the word is also displayed. The clinician has control of the starting point: word/syllables, phrase, or sentence, depending on the individual's severity. Portions of the modified eight step continuum are to be applied to increase drilling of visual and auditory cueing through the use of simultaneous production, miming of target stimulus, and repetitions of target stimulus.

/Intɛli/ has also incorporated general MIT elements to assist clinicians in using melodic intonation within their therapy sessions. One of the elements is the tempo, consisting of the three different options: slow, medium and normal. Slow is approximately two seconds per syllable, medium is about one second per syllable and normal is faster than one second per syllable. In addition to the different tempos, a visual cue was also integrated to correspond to each of the tempos. The visual cue used is the outlining of each box which contains the target syllable at the word level.

The timing and type of feedback provided to the individual is important in aiding with progress towards speech intelligibility. Pertaining to this study immediate verbal feedback will be provided at the syllable/word level by clinician on participant's verbal production of target stimuli. The feedback given will be dependent upon clinician's perceptual judgment of participant's production. In incorrect production, the clinician is to replay the video-audio recording and encourage another attempt to occur. Visual production of target stimuli might have to be produced by clinician to give additional feedback of appropriate production. In correct production, the clinician will give verbal praise and encouragement of repetition of target stimuli will follow. The participant will also receive immediate auditory feedback through the use of Praat software. The participant will record their production and clinician will immediately replay, allowing participant to judge their verbal production. As participant moves through the different levels of complexity, theclinician is encouraged to reduce or delay feedback.

Purpose

The purpose of the study is to explore the success of a computer program (/Intɛli/) that incorporates MIT, visual cues, auditory cues, portions of modified-eight step continuum along with voice recordings for instant feedback to increase speech intelligibility of an individual with AOS. The research question is, if the use of /Intɛli/ will increase the speech intelligibility with multisyllabic words of an individual with AOS? The null hypothesis is will result in no change in the participant's speech intelligibility using /Intɛli/.

CHAPTER 2: METHODS

Research Design

The current study employed a single-subject multiple baseline design across complexities (syllable/word, phrase, sentences). Probes were completed to examine generalization across complexities. The independent variables for this study were the computer software and the number of therapy sessions the participant received (19 total). The dependent variable was speech intelligibility of multisyllabic words beginning at the word/syllable level. The criteria to progress to the next level of complexity were set at 80% intelligible speech across 3 consecutive sessions at each level.

Defining speech intelligibility

In this study speech intelligibility is defined as the accuracy with which a typical healthy listener can understand a spoken word or phrase (Marsh, 1999). It refers to the match occurring between the speakers intended message and the listener's response, a perceptual judgment (CASANA).

Participant

History

The participant A.P.G, is a 13; 0 old female (on initial day of this study) who was, first evaluated at the University of Texas at El Paso, Speech Hearing and Language Center in the summer of 2007 and re-evaluated in the spring of 2010 by a graduate student clinician (refer to table 2.1 for summary). Based on information gathered through a parent interview and questionnaire, it was determined that A.P.G's dominant language at home is Spanish; however at school both Spanish and English are spoken. She is currently placed in a kindergarten class due

to her non-proficient skills in the English language, her cognitive level, and unintelligible speech productions. As reported by the parents, she used one word utterances at 3 years old and two-word combinations at 6 years old. According to developmental milestones by Owens (2008), the participant demonstrates a developmental language delay. A typical developing child is expected to be using one word utterances at approximately one-year of age and two-word combinations at approximately two-years of age. A.P.G's expressive language is characterized by one word utterances, and occasional gestures. Her expressive oral language is best described as unintelligible. She primarily uses Spanish and when combining more than one word within an utterance her speech intelligibility decreases.

Assessment

A.P.G passed a pure tone hearing screening test in the spring of 2010 in a sound treated booth at 20 dB HL at 500Hz, 1000Hz, 2000Hz and 4000Hz.

A modified version of the Apraxia Profile (in Spanish) was administered. A.P.G's facial symmetry is typical; however lateral lingual range of motion appeared reduced.

The second part of the modified Apraxia Profile was utilized to assess her articulation. When she was asked to repeat syllables, increasing from one to four syllable words, her speech intelligibility decreased as the word syllable length increased. The diadochokinetic syllable rate /pʌ tʌ kʌ/ was discontinued after A.P.G could not repeat the phonemes individually, /pʌ/, /tʌ/, /kʌ/. Her productions of monosyllabic words are characterized as syllable simplifications and cluster reductions. Her phonemic inventory could not be assessed due to her inconsistent productions and decreased speech intelligibility.

A.P.G.'s receptive language was assessed using Test de Vocabulario en Imagenes Peabody (TVIP) in 2009, Peabody Picture Vocabulary Test (PPVT) in English, and The Receptive One-Word Picture Vocabulary Test Spanish-Bilingual Edition (ROWPVT) only in Spanish, in 2010. All results were interpreted with caution since the normative data did not reflect the current participant's population. At the time of administrating the TVIP A.P.G was 11 years 4 months and 12 years 6 months for PPVT and ROWPVT tests. On the TVIP her age equivalent score was eight years and six months, scoring in the 4th percentile. She demonstrated basic interpersonal communication skills in Spanish by responding to the clinician's requests and following directions. On the PPVT her age equivalent was six-years and one-month, scoring in the 1st percentile, and on the ROWPVT her age equivalent score was seven-years and four-months, scoring in the 4th percentile.

Administration of the Expressive One Word was attempted but was terminated due to her unresponsiveness to the stimuli. Part IV of the modified Apraxia Profile was used to assess A.P.G's expressive language. Her utterances were characterized as single words, highly unintelligible, and the production of multisyllabic words were reduced to one to two syllables. Some of her verbal productions were in English, demonstrating use of compensatory strategies. A.P.G. produced words that were the easier from the two languages. For example, for the target word, "azul" ("blue" in Spanish), A.P.G. may say /bu/ (an approximation of "blue"). A.P.G was diagnosed as having severe expressive/receptive language disorder secondary to severe AOS.

Table 2.1. Summary of participant's history

Subject	Age (yrs; mo.)	Hearing Screening	Diadochokinetic rate avg.	TVIP (2009)	PPVT (2010)	ROWPVT (2010)	Diagnosis of Severity
A.P.G	13; 0	Passed	Discontinued could not repeat individual phonemes /pʌ/, /tʌ/, /kʌ/	8;6 age equivalent 4th percentile rank	6-01 age equivalent 1st percentile rank	7;4 age equivalent 4th percentile rank	Severe; expressive and receptive language secondary to severe AOS

Treatment History

Individualized therapy for A.P.G has been provided at the University of Texas at El Paso, Speech, Hearing and Language Center from 2007 until present. Her therapy goals were created and defined according to the current clinician. As clinicians changed, one of the goals remained consistent, the use of total communication in therapy. The use of total communication encompasses the application of oral speech, signs (American Sign Language included), gestures, and written language within therapy. It was later modified to focus on manual and/or verbal productions. In the summer of 2010 Dynamic Temporal and Tactile (DTTC) cueing was implemented as a treatment method to increase motor planning and programming, focusing on CV or VC verbal productions of 10 words. This DTTC method shifted the treatment approaches to targeting the increase of speech intelligibility in one word utterances. The most recent goal (2011) has been restructured to increase A.P.G's speech intelligibility of bisyllabic, multisyllabic words and two word phrases through the use of DTTC.

Stimulus materials

Dell Studio 1737 Laptop was used for this study with a 64-bit operating system using 2007 Windows Vista Home Premium edition. /Intɛli/ software was installed in the computer which used a Logitech microphone for all the recordings. Praat software was used to record and export the recordings as WAV files. A Sony IC-PX720 hand camcorder was used to record each of the therapy sessions.

Procedures

A.P.G's caregiver was given an informed consent form to obtain permission for their child to participate in the study. The form was developed using the format provided by the Institutional Review Board forms. The caregiver was asked to read and sign the consent form. A copy was given to the parents for their personal records. In order to maintain confidentiality the participant's initials were used on all forms and data.

A total of 30 multisyllabic (3 to 5 syllables) words were chosen in English for this study. Based on those words, the equivalent Spanish translation was derived. The number of syllables per word varied according to the translation; however, the researcher attempted to keep the number of syllables equivalent in both languages.

The participant was scheduled to receive therapy, three times a week for an hour each session for four weeks (12 sessions). Then due to schooling circumstances a different experimenter provided therapy two times a week, total of seven sessions, and engaged with the program for only 20 to 30 minutes per session, continuing with data collection.

Treatment administration

All therapy sessions took place at the University of Texas at El Paso, Speech Hearing and Language Center. The therapy room was approximately 9 by 12 feet with double sided mirrors composing two walls of the room, a microphone located in the ceiling which connects to an outbox speaker found in the observation room (behind the mirrors). Only the experimenter and the participant were present in the therapy room. Noise levels outside of the therapy room were kept at a minimum.

Baseline

Baseline was established by random selection of 10 pictures that corresponded to the 30 multisyllabic words used for /Intɛli/ (refer to figure 2.1). The participant was presented with the pictures and asked to verbally label the one pointed to by the experimenter. The verbal production was elicited by the experimenter saying, "Dime que es?" (tell me what this is). A.P.G gave a verbal production, the experimenter proceeded to the next picture (left to right). No verbal, visual feedback or positive reinforcement was given after her verbal productions, however acknowledgement of her production was addressed with "bueno, que es la siguiente" (ok, what is the next one). The 10 pictures were administered three times throughout the therapy session, 20 minutes apart and activities were played in between baseline data collection. A binary system was used by the experimenters, a "+" was used if the participant's word production was intelligible and an "-" was used if the production was unintelligible. There was a camera present in the therapy room that recording every therapy session.

Figure 2.1. /Intɛli/ multisyllabic visual aids. These visuals were used to elicit multisyllabic verbal productions and score speech intelligibility for baseline.

Initiation of /Intɛli/ & Praat

In the session following baseline data collection, /Intɛli/ was introduced and thereafter utilized for all therapy sessions. First the external microphone and mouse were connected to the computer. Then the introduction of /Intɛli/ began by double clicking on the desktop icon. /Intɛl/'s homepage appears displaying boxed icons with the corresponding name above: "level 1" (words), "level 2" (phrases), "level 3" (sentences), "administrator", and "quit", (appendix A1). The experimenter double clicked on "level 1" (words) icon to begin giving therapy at the word level, /Intɛli/ displays the syllables automatically for target words in English.

Next, the Praat icon located on the desktop was double clicked, once opened it displayed two windows. The window labeled, "Praat Picture" was closed and the window labeled "Praat Objects" remained opened. On that window "new" was clicked and from the drop down menu "record stereo Sound" was chosen, another window appeared "SoundRecorder". All the settings on this window remained the same. The windows from both programs were kept open side by side (appendix C1).

Therapy began with the experimenter using /Intɛli/. A multisyllabic word was displayed on the screen (words are randomized) and the experimenter first changed the language to Spanish by clicking on the Mexican flag found at the bottom right corner. In the first therapy session, the experimenter explained and simultaneously demonstrated the action of each feature to A.P.G., and then she was given the opportunity to become familiar with the features by allowing her to click on each of them.

/Intɛli/ & modified eight step continuum

After all functions were addressed, therapy continued with A.P.G clicking on "video" for auditory and visual production of target word. A.P.G. was encouraged to verbalize the multisyllabic word. If verbal productions were perceptually judged to be unintelligible, positive reinforcement was given to not discourage her, "bien intento, vamos a comenzar con la primer sílaba" (good try, let's begin with the first syllable). The experimenter began with the first syllable (only one turned over) and clicked on corresponding video-audio recording. Participant then attempted verbalization of targeted syllable. If unsuccessful, the experimenter provided model saying, "veme" (look at me) and produced target syllable; followed by, "tu turno" (your turn). This pattern from /Intɛli/ to experimenter continued until the target syllable was perceptually judged to be intelligible. Once intelligibility was achieved, the experimenter proceeded to the next syllable, clicked on video-audio recording for target syllable (only syllable turned over), and attempted verbal production of that syllable. When consistent intelligible productions of the targeted syllable were established, then the experimenter proceeded in combining and reinforcing the first with the second syllable. This was executed by exposing corresponding graphemes along with immediate production of each targeted syllable after corresponding "video" was clicked. Positive reinforcement and feedback were consistently given by the experimenter encouraging verbal production to continue. This pattern continued until both syllable productions were judged to be intelligible. Then moved on to the next syllable (turning over the previous cards and only exposing the target syllable), and the video-audio recording was clicked, she attempted production, if unintelligible, experimenter modeled target syllable. Once consistency with the verbal production was perceived to be correct for each target syllable, then all syllables were combined and drilled. The patterns continued until all syllables

for the targeted multisyllabic word were attempted individually and in combination, (figure 2.2 provides a further explanation).

At this point if A.P.G's speech production of targeted multisyllabic word was perceptually judged to be intelligible, then she was encouraged to speak into the microphone to record her production, using the Praat software. The /Intɛli/ window was maintained open so she could refer to the visual and orthography of the target word. The experimenter clicked on the record button, counted down from three manually cueing A.P.G. to verbally produce the word. The stop button was clicked when her production was completed. Her recording was replayed, giving immediate feedback of her verbal production and the video-audio recording of the target word. A.P.G. was asked to compare her production to the video-audio recording, if she judged her production to be unintelligible, then she was given another opportunity to record the target multisyllabic word. If A.P.G. demonstrated frustration, which was usually indicated by her whining or saying no, then that production was saved.

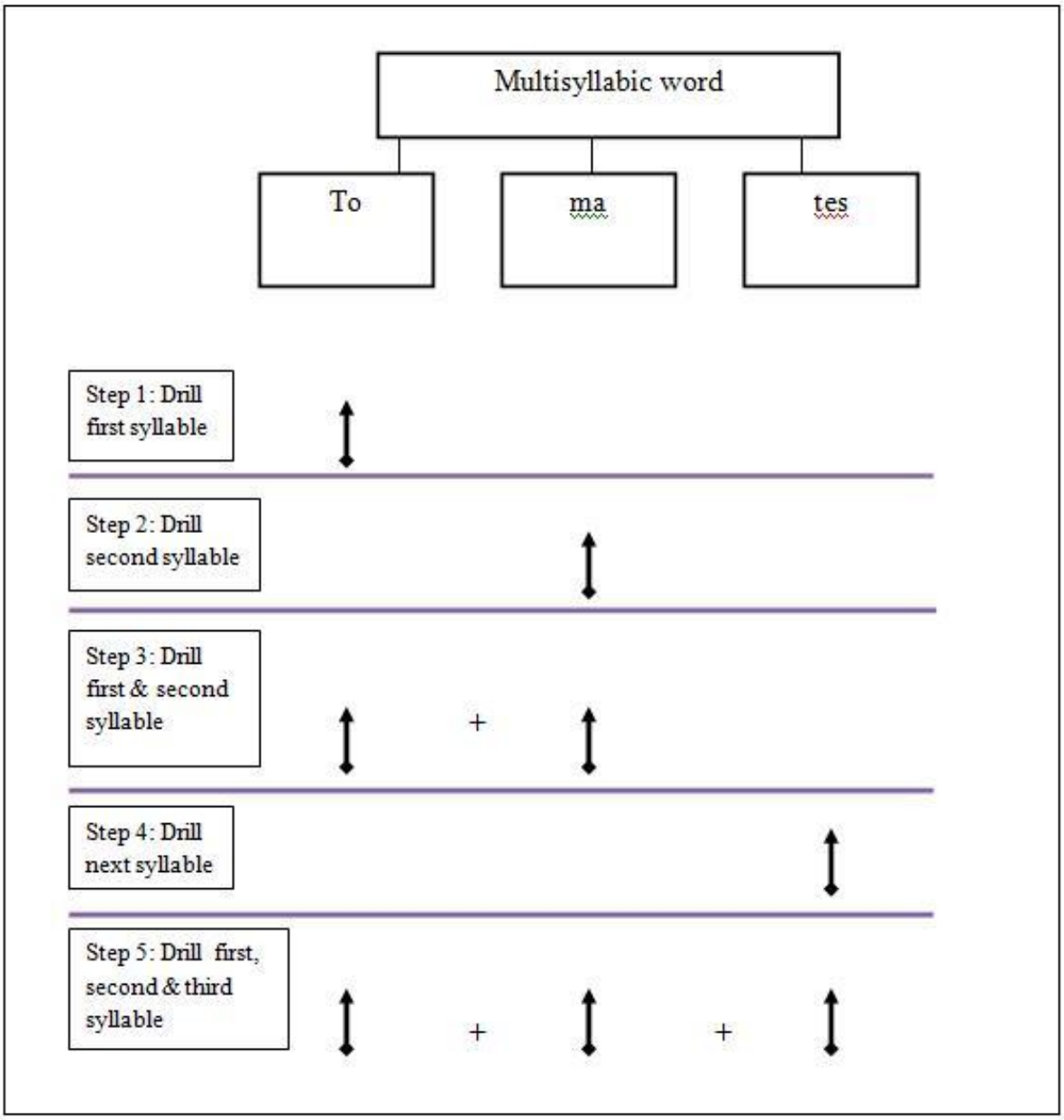


Figure 2.2. Example of drilling pattern of multisyllabic word. Visual of general pattern experimenter established with drilling of multisyllabic words.

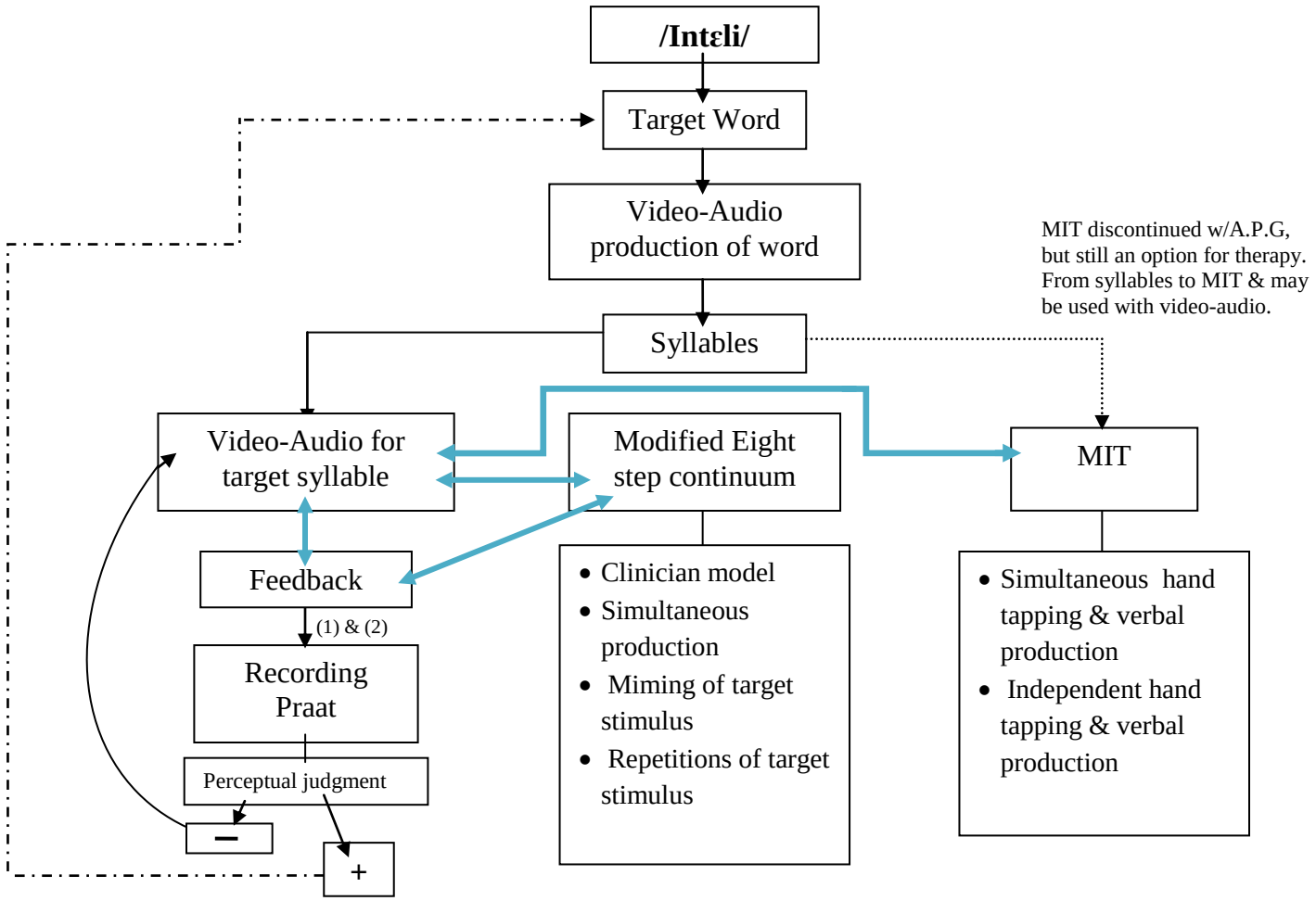
Saving verbal productions

Verbal productions were saved by using the "SoundRecorder" window, a box labeled "name", was clicked and the name of targeted multisyllabic word was typed. Then the icon "Save to list" was clicked and that recording showed up on the Praat Objects window. Then it was ready for the next multisyllabic word to be recorded and the same process took place for all targeted words for all sessions. After therapy was completed and all productions for that session were saved and appeared in the "Praat Objects" window, "write" was chosen from the options menu. On that drop down menu "Write to WAV file…" was chosen. A new folder was created and the folder name was renamed to correspond to the therapy date. "Save" was clicked to ensure filing of data. This process continued until all recordings for that therapy session were saved in the corresponding folder for that therapy date.

The voice recordings were also saved using the program iTunes. A new playlist was created with the initials A.P.G. and after all the voice recordings were saved in their corresponding folder (using Praat); it was opened (desktop, thesis recordings folder, corresponding therapy folder). Once opened all the voice recordings appeared, control + A was pressed to highlight and select all the voice recordings in that folder. Then iTunes was opened with A.P.G playlist opened, and then the mouse was used to click on the highlighted section in the folder and dragged into itunes. After all voice recordings were imported they were highlighted, left mouse was clicked on the drop down menu "Get Info" was chosen, in the new window the tap labeled "Info" was clicked and under artist the therapy date was typed. Next "Ok" was clicked and the artist name became the therapy date for the selected voice recordings. All the recordings appeared in order from the first therapy session to the last therapy session.

/Intɛli/ & MIT

The use of melodic intonation began with the first syllable of the word with hand over hand tapping with her left hand and a simultaneous verbal production. This continued until the action and verbalization were simultaneous. When the behavior was established the experimenter and participant attempted to hand tap independently and simultaneously verbalize target syllable. A.P.G. demonstrated difficulty at this step, so the experimenter attempted to revert back to previous step, but A.P.G used the mouse and clicked on the video-audio production and attempted verbalization afterwards. The MIT method was abandoned in this research due to her continuous demonstration of difficulty and her preference in engaging with the video-audio recordings.



Direction for therapy

- /Intɛli/ → multisyllabic word displayed → video-audio for entire word → begin with first syllable
- Video-audio, feedback (criteria met), recording, (+) new word, (-) repeat video-audio OR
- Video-audio w/ MIT, feedback (criteria met), recording, (+) new word, (-) cont. drilling OR
- Video-audio w/ modified eight step, feedback (criteria met), recording, (+) new word, (-) cont. drilling

Criteria from feedback to recording

(1) All target syllables drilled

(2) Participant passed experimenter's perceptual judgment

Figure 2.3. Illustrating the therapy process(es) options designed for /Intɛli/ with the incorporation of Praat for recording, modified eight step continuum, and MIT.

Inter-rater reliability

A self-identified bilingual graduate student volunteered and listened to all voice recordings. She was handed two sheets of paper numbered from 1 to 110. The computer used for therapy was used for inter-rater reliability. The computer was positioned with the screen facing away from the volunteer and she was handed a pair of headphones, the experimenter also had a pair of headphones. The graduate student was asked to write a "+" if she understood the voice recording and to write the word she heard next to it and a "-"if she did not understand the voice recording. The recordings were replayed as many times as she requested. The experimenter opened iTunes, located the play list labeled A.P.G, asked rater to put on the headphones and listen to the voice recordings, and to say if she needed to hear the recording again. The experimenter and graduate student listened to all the recordings and analyzed each point. The inter-rater point to point reliability was 93%. The number was derived by taking the number of voice recordings agreed, which was 102 total, divided by the number of voice recordings agreed and disagreed, which was 110 total. All disagreements were resolved through discussion.

CHAPTER 3: RESULTS

The quantitative results for the research question, increasing speech intelligibility through the use of /Intɛli/ (visual-audio recordings), modified eight step continuum, and the Praat program with an individual diagnosed with AOS is illustrated by Figure 3.1. Qualitative data was collected through daily assessment logs of the participant's engagement with the treatment methods. The assessment logs were recorded by the experimenter providing treatment.

After baseline was collected and treatment was administered, A.P.G. demonstrated an increase in speech intelligibility. The speech intelligibility improvement patterns continued until the consistency of the sessions were disrupted. Three extensive breaks took place from December 23nd to January 2rd (10 days due to holidays), January 8th to the 16th (9 days due to experimenter's absence) and January 25th to February 8th (15 days due to clinical scheduling).

On February 9th a different experimenter began to administer treatment and the total treatment time of /Intɛli/ was reduced (from 1 hour to 20-30 minutes). This was done out of necessity due to the schedule of the clinic A.P.G received therapy. Treatment administered on this date consisted of only two words and A.P.G.'s speech intelligibility was judged to be 100%, refer to table 3.1 for results of all therapy sessions. On February 16th the experimenter inadvertently provided therapy at the phrase level, therefore data was not collected at the word level. When therapy continued at the word level, although speech intelligibility varied, A.P.G's speech intelligibility was maintained at or above 50%.

A.P.G. did not meet criteria of maintaining 80% speech intelligibility across three consecutive sessions, nor did she demonstrate generalization at the phrase level (probes provided throughout treatment). However, effect size was calculated by applying the percent of non-overlapping data (PND) (Scruggs, Mastropieri, & Casto, 1987). PND is calculated by

identifying the highest baseline data point and then counting all intervention data points that surpass the detected baseline point. In this study, 16 data points were identified to be above 10% speech intelligibility, the highest baseline data point. Then the total number of surpassing intervention data points is divided by the total number of intervention data points. In this study, 16 was divided by 17, which is the total number of intervention data points. The PND score was 94%, which indicates that the treatment was highly effective.

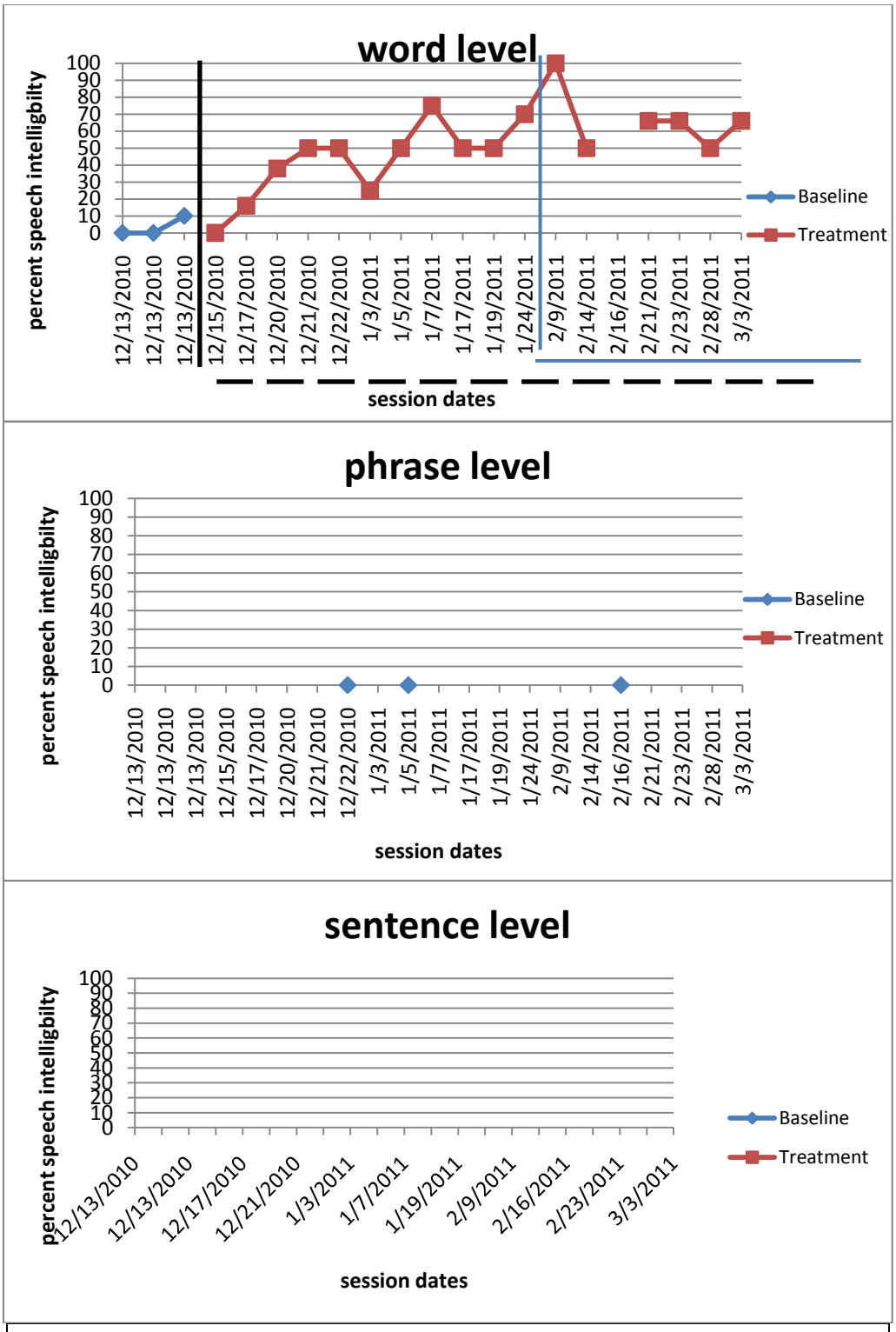


Figure 3.1. Multiple baseline across complexity. Graphs the participant's percent speech intelligibility for each session.

Table 3.1. Data and corresponding output

Therapy dates	**Total number of targeted words**	**Total number of intelligible speech production**	**Percentage**
12/13/2010	10	1	10%
12/15/2010	6	0	0%
12/17/2010	6	1	16%
12/20/2010	8	3	38%
12/21/2010	8	4	50%
12/22/2010	8	4	50%
1/3/2011	8	2	25%
1/5/2011	8	4	50%
1/7/2011	8	6	75%
1/17/2011	10	5	50%
1/19/2011	10	5	50%
1/24/2011	10	7	70%
2/9/2011	2	2	100%
2/14/2011	4	2	50%
2/16/2011	-	-	-
2/21/2011	3	2	66%
2/23/2011	3	2	66%
2/28/2011	2	1	50%
3/3/2011	3	2	66%

CHAPTER 4: Discussion

The purpose of this study was to explore the success of a bilingual computer program (/Intɛli/) that incorporated MIT, visual cues, auditory cues, portions of the modified-eight step continuum, and voice recordings for instant feedback to increase speech intelligibility with an individual with AOS. The research question posed for this study was, whether the use of /Intɛli/ would increase speech intelligibility with multisyllabic words of an individual with AOS. The null hypothesis was that there would be no change in the participant's speech intelligibility using /Intɛli/.

After 18 therapy sessions, A.P.G did not reach criteria, 80% intelligible speech across three consecutive sessions at the word level. Generalization did not occur at the phrase or sentence level with multisyllabic words, nor were any words used in spontaneous speech. Rosenbek et al. (1974) reported that children with apraxia of speech progress very slowly during therapy and are slow to show gains. The current study supports Rosenbek et al. (1974) statement; A.P.G has been receiving therapy for four years at the same clinic and has been exposed to different clinicians. Minimal gains have been reported, by past clinicians with regards to treatment outcomes and her spontaneous speech has been judged as highly unintelligible.

A.P.G and /Intɛli/ results and observations

Upon visual inspection of the data, the results support the use of /Intɛli/'s visual-audio cues, the modified eight step continuum and voice recordings (MIT was not utilized in this study), due to the increase in A.P.G's speech intelligibility in multisyllabic words. After the seventh therapy session, her speech intelligibility was perceptually perceived at or above 50%,

which continued until the last day of therapy. Fifty percent speech intelligibility or higher was maintained even after a break (of more than nine days) occurred between sessions, after a change in experimenters took place, and after a reduction of interactive time (from one hour to 30 minutes) with /Intɛli/ occurred.

In comparison to previously structured therapy sessions, when verbal productions of multisyllabic words were targeted (majority were probes), speech intelligibility was reported unintelligible by previous clinicians. However, verbal productions of monosyllabic or bisyllabic words were overall perceived to increase in speech intelligibility with the aid of visual stimuli and repetition of targeted words. The generalizations of the targeted words were reported to be none to minimal by previous clinicians. Commonalities between the structured sessions and the use of /Intɛli/ with A.P.G were the improvements in speech intelligibility through the use of visuals, repetition and the lack of generalization when complexity was increased. The finding that generalization did not occur as complexity was increased, is similar to that reported by Yoss and Darley (1974), in which minimal carryover took place from single-word productions to polysyllabic words in carrier phrases and in spontaneous speech samples, in children ranging in age from six to 11 years of age, and with a range of severity levels.

A.P.G.'s speech intelligibility improvement of multisyllabic words was further emphasized in two therapy sessions. During the 11th session of therapy, A.P.G. was asked to verbally identify two pictures in random order (before therapy of target word was administered). She labeled both pictures; "enemigo" (enemy) and "tomates" (tomatoes) and was perceived as intelligible. On the 16th session the experimenter reported that A.P.G. spontaneously and intelligibly identified, "tomates" (tomatoes) and "Mexico" when pictures were displayed.

The spontaneous intelligible productions of A.P.G in this study support Wertz, LaPointe, and Rosenbek's (1991) statement of the importance of treatment for individual's diagnosed with AOS to emphasize drilling and intensive repetitions of targeted stimulus and not solely focus on lingual movements for the improvement of their speech productions.

Yorkson et al. (2010) reported that retention and learning of motor skills might eventually occur if modeling is provided, practice, and experience of movement skills, all of which modalities were incorporated in /Intɛli/. With /Intɛli/, the drilling of each multisyllabic word began at the syllable level which was incorporated into /Intɛli/'s methodology of continuous repetitions/practice of each syllable (Figure 2.2). Furthermore, A.P.G was continuously provided with immediate feedback for each syllable. Feedback consisted of either replaying /Intɛli/'s video-audio recordings or the experimenter modeling through the use of any step in the modified eight step continuum. Auditory feedback was provided after verbal production of multisyllabic words. When using visual modalities, the adequacy of the targeted sound or sequence is increased (Rosenbek et al., 1974). Therefore, visual-audio feedback was always provided. One may infer that A.P.G's maintenance of speech intelligibility at or above 50% was aided by consistently providing modeling (visual-auditory feedback and experimenter), practice (repetitions of target stimuli) and experience of movement skills (drilling of targeted stimuli).

/Intɛli/'s strengths

/Intɛli/ has been designed to be a bilingual (English and Spanish) computer software program that contains multisyllabic words in both languages (ranging from three to five syllables). The target multisyllabic word can be accessed immediately in either language by

clicking on the corresponding flag that represents the language and the displayed screen does not close nor become disrupted making the program easy to use for bilingual clients.

The 30 multisyllabic words, which are broken down by syllables and are displayed with a corresponding picture, were incorporated for every multisyllabic word. The 30 multisyllabic words were also used at the phrase and sentence level along with their corresponding picture for each target word, striving for the generalization of speech intelligibility of targeted words. In attempting to generalize the targeted 30 words, functionality, spontaneity and vocabulary are increased.

Features that have been incorporated into /Intɛli/ are (1) MIT, which highlights the target syllable at the chosen pace (slow, medium, and normal), (2) video-audio recordings for the targeted multisyllabic word in both languages, (3) video-audio recordings for each syllable of the targeted multisyllabic word also in both languages, (4) the option of applying backward training therapy only for English, (5) folders for participants can be created where notes could be kept, and (6) video-audio recordings, pictures, and target words could be uploaded to individualize program. This allows for flexibility in the selection of appropriate target words, according to the individual's needs, without compromising the use of the other features (i.e. MIT, video-audio recordings).

/Intɛli/'s weaknesses

In this current study, /Intɛli/ could not be used alone for speech intelligibility treatment. Praat and the modified eight step continuum were applied and administered by a trained clinician. The program only contained and displayed multisyllabic words. The chosen words may not be considered functional by all. Ideally, a speech-language pathologist would be able to

choose multisyllabic words from a word bank that are most functional and appropriate for the particular client. The video-audio recordings used for the multisyllabic words clearly demonstrated labial movements but that was not always the case for lingual movements of target stimuli. Therefore, vowel productions and lingual movement patterns for syllables or multisyllabic words were rarely viewed if at all. The program as of now may only be installed on a Windows operating system.

Subjective comments

/Intɛli/ contains weaknesses that were noted by experimenters, but the strengths appeared to out weight those flaws. One of the experimenter's stated, "I think the program's benefits are that it provides feedback in multiple modalities so I think it helps reinforce the target production." In respect to A.P.G and the use of /Intɛli/ the experimenter mentioned that, "A.P.G. is extremely severe, so I don't think that it's [/Intɛli/'s] full benefits could be seen and appreciated, but it [/Intɛli/] might be more impactful with other less severe people." The experimenter was asked if any other comments would like to be made about /Intɛli/ and/or A.P.G and she responded, "I think words in the program should definitely be more functional so that generalization is more meaningful, and I'm not sure whether repetition would have lead to spontaneous production of the target word in A.P.G's case."

A.P.G.'s father was informed and presented with all of the data to include replaying several recordings from the first therapy session and from last sessions for his perceptual judgment about her speech intelligibility. When he heard some recordings from the last sessions he said, "Es A.P.G.? Suena como otra persona. Esta es la primera vez que oigo claramente diferente palabras. Es increíble." (Is it A.P.G.? She sounds like a different person. This is the

first time I clearly hear her say different words. It's incredible). When asked if he had heard her use any of the targeted words spontaneously at home or in any other setting he responded with, "no, estas grabaciones son mi primer vez " (no, these recordings are my first time). He was informed about the routine and what treatment entailed and he was then provided with the word list.

Home program

The next step that could be taken with /Intɛli/ is the possibility of making it a home program that could enhance what is being implemented in therapy. Family members could be trained on the use of /Intɛli/ along with the modified eight step continuum, MIT and Praat. /Intɛli/ could be individualized by inputting meaningful words to the individual (i.e. the names of family members). The corresponding videos would be uploaded (a family member would have to record them) and it allows for personalized pictures to be uploaded.

Yorkston et al., (2010) and Mass, Robin, Austermann Hula, Freedman, Wulf, Ballard, and Schmidt (2008), report that in working more intensively on a smaller set (from 5 to 10 words or utterances) is a way for more practice to occur and as improvement is noted then generalization would be next. It would be recommended for the family to select no more than 10 words at a time that are meaningful to the individual and are produced unintelligibly. These words would be uploaded to /Intɛli/ where they would begin drilling at the word level. The time engaged with the program would depend on the individual, family dynamics and other variables, but it would be recommended to drill everyday for a minimum of 30 minutes. Yorkston et al. (2010) suggested shorter, more frequent sessions to maximize motor learning. As the individual's productions are perceptually judged to improve then they would progress to the phrase level and then sentence, followed by spontaneous speech productions.

The benefit of providing therapy with /Intɛli/ at home with more meaningful words is that it increases the probability of generalization from /Intɛli/ to labeling actual objects, and the continuous reinforcement that would be in place. If the words were to represent concrete objects, then they could be used as reinforcements when the individual produces an intelligible utterance.

Future expectations for /Intɛli/

As technological advancements continue to progress, one of the expectations for /Intɛli/ is to be updated but without compromising simplicity and effectiveness. Therefore, it will still be helpful not only for future clinicians, but for future family users. For the time being, /Intɛli/'s direction is to become an application that may be downloaded using an iPad, iPhone, and/or android-based smart phones.

The changes to /Intɛli/ would not only involve the word selection, but also the visuals provided for each syllable and word productions. Another challenge for /Intɛli/ would be to provide a visual of the lingual movements involved in the production of the word and its syllable productions not just immediate feedback of lingual placement and movement. This feature would facilitate visualization of both consonant and vowel productions. Ideally, the targeted lingual movement would be displayed where the video-audio production is currently displayed and next to it, the individual's actual lingual movement. Both the experimenter and participant could see lingual movement in real time. It is incorporating technology available today regarding capturing movement wirelessly, for example, the Wii® is capable of displaying the users' movements on the screen, providing immediate feedback of their movement, through a virtual representation. The individual changes their movement and position according to the

virtual representation displayed. This idea would be incorporated into /Intɛli/ providing the individual with immediate visual feedback of their lingual movement and position through a virtual representation of their oral cavity. The auditory feedback would be provided by the experimenter.

Future research

The current study used /Intɛli/ with individual diagnosed with severe AOS. Future research using /Intɛli/ should focus on individuals with varying severities of AOS to assess their speech intelligibility. The new features that become incorporated into /Intɛli/ (i.e. the lingual movement in real time) would have to be assessed.

Limitations

One of the limitations of the study was that the experimenter only used a single subject. Therefore, the findings from this study cannot be generalized to the other individuals with apraxia of speech. This is due to the individualized nature of each child's manifestation of the disorder. There was a change with experimenters, therefore might have been variability in the administration of treatment. Motivational phrases used to engage participant in therapy, the feedback phrases used when participant was correct with her verbal production of multisyllabic word. Establishment of rapport (demonstrated by smiling and/or hugging) between the participant and experimenter might have taken a few sessions, which might have affected production of speech intelligibility and the number of targeted multisyllabic words. There was also a change with the interactive time between the participant and /Intɛli/ from one hour to 30 minutes per session. This impacted the number of administered and drilling of multisyllabic words which might have impacted the speech intelligibility output for those sessions.

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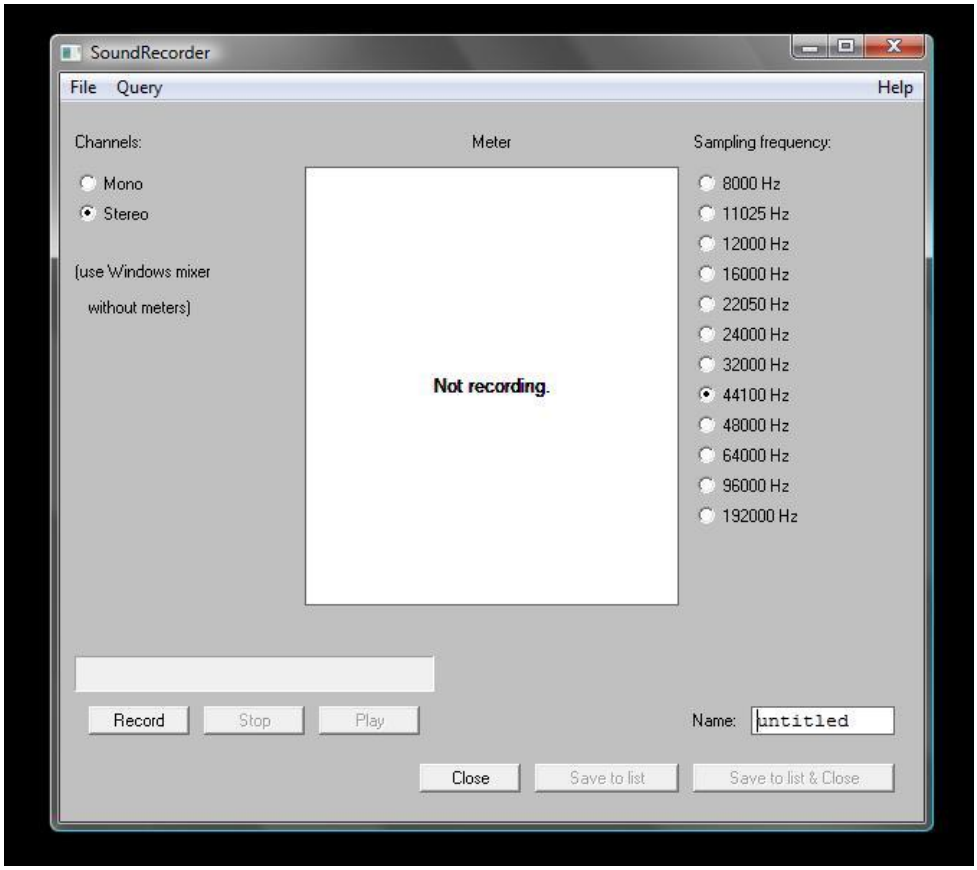
Appendix A

Print Screens of /Intɛli/ and Praat

A1

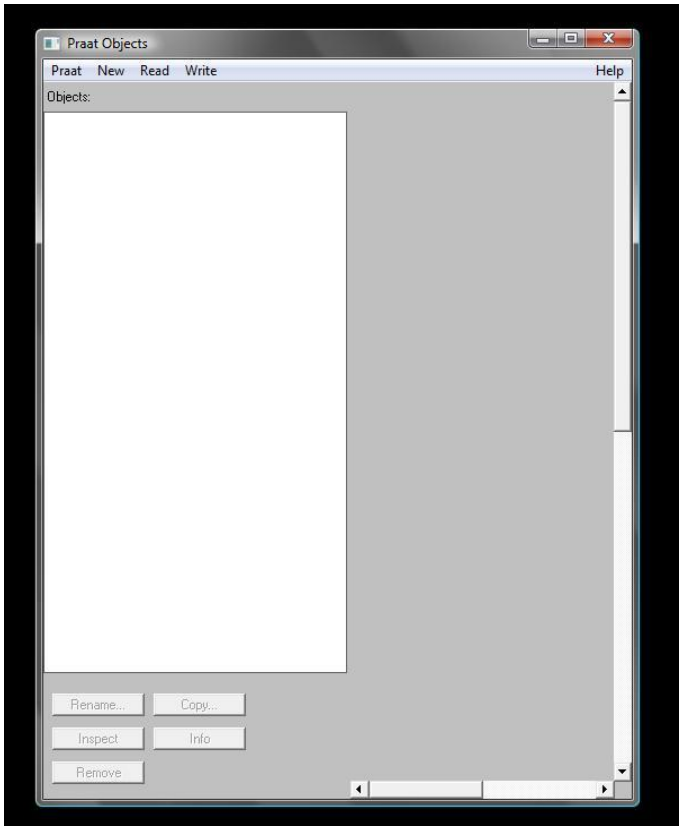
A2



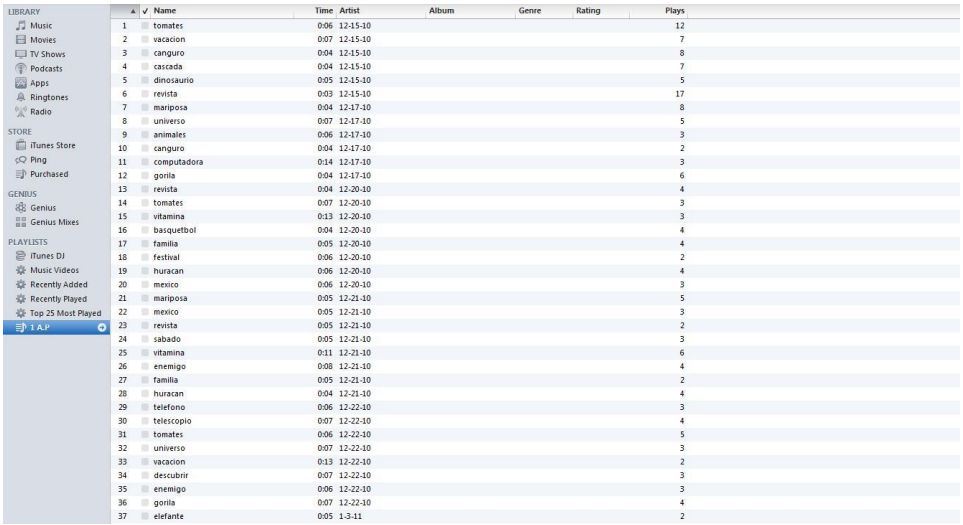
Appendix B

Print Screen of Praat and Itunes

B1

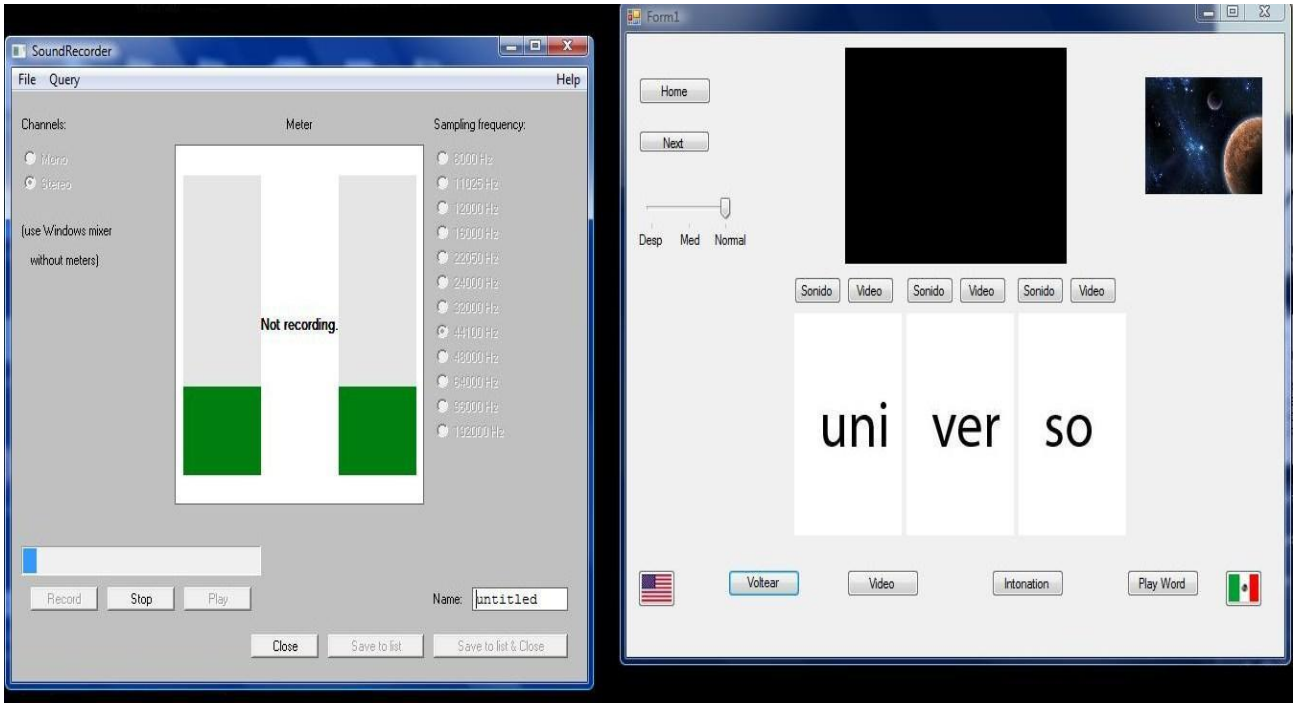


B2

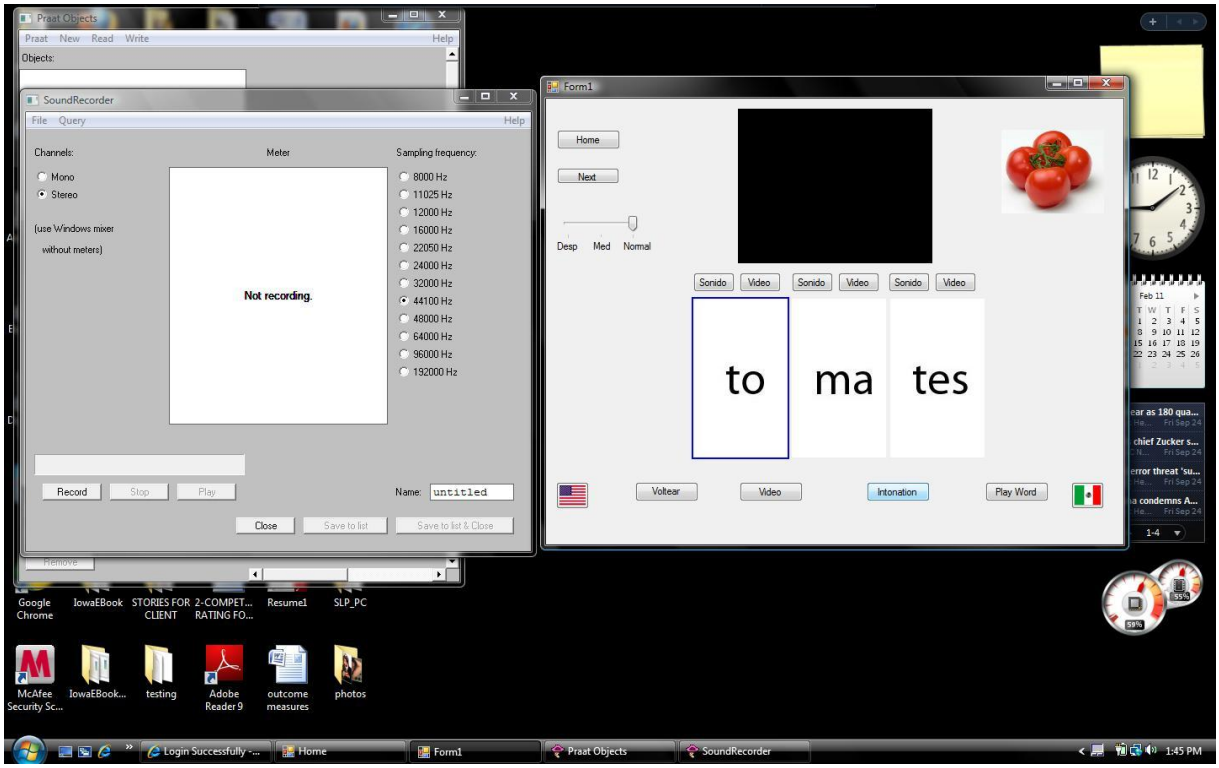


Appendix C

C1



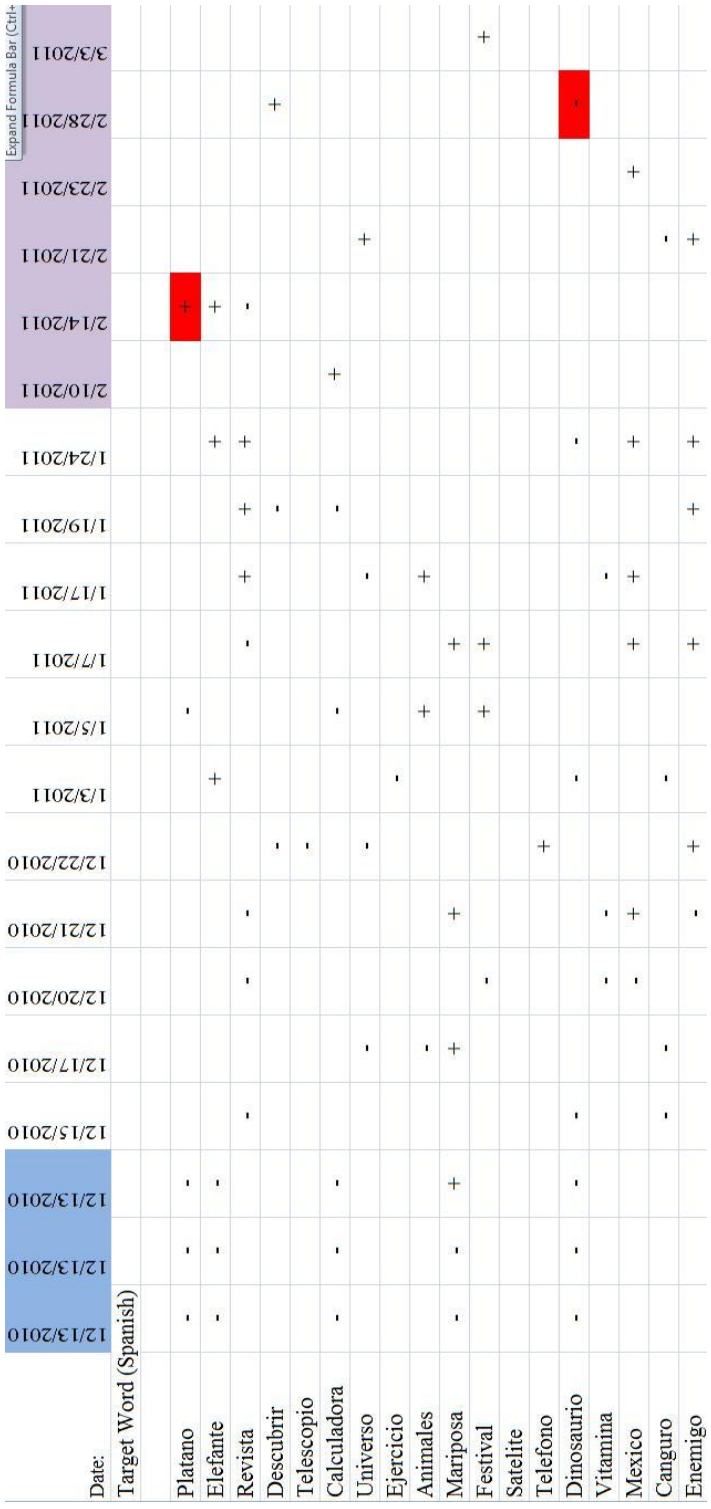
C2



Appendix D

Results of targeted word for each therapy session

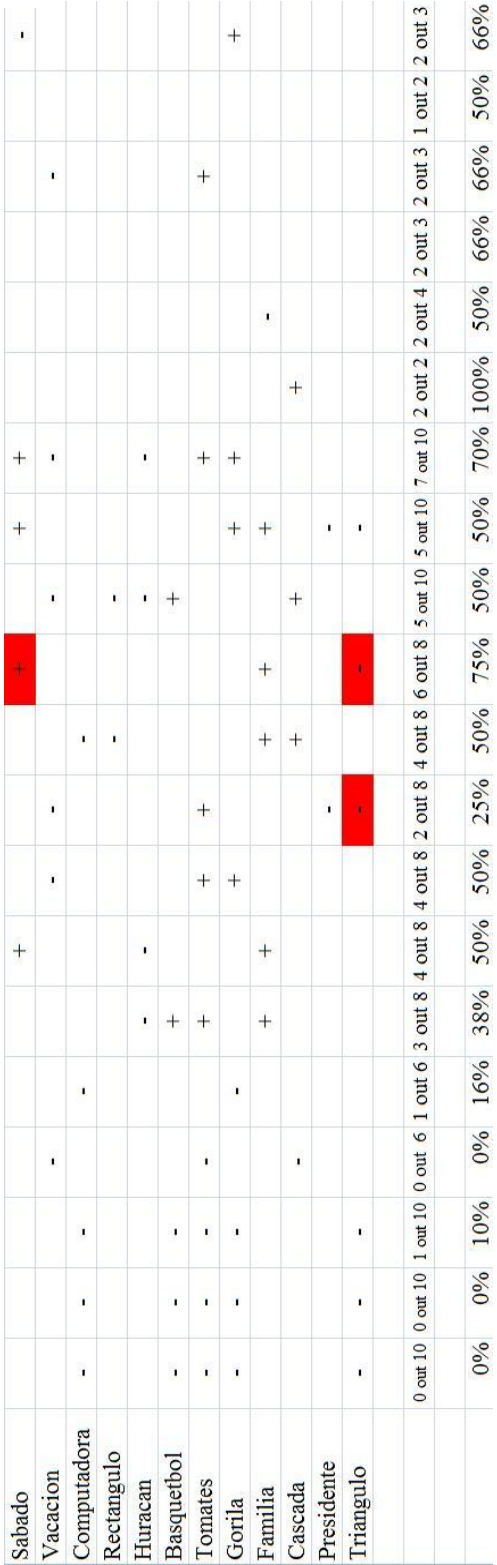
D1



Appendix E

Results of targeted word for each therapy session con't.

E1



Appendix F

All multisyllabic words used for /Intɛli/

F1

English	**Spanish**
1. Ba-na-na	Plá-ta-no
2. El-e-phant	E-le-fan-te
3. Mag-a-zine	Re-vis-ta
4. Dis-co-ver	Des-cu-brir
5. Tel-es-cope	Te-les-co-pio
6. Cal-cu-la-tor	Cal-cu-la-do-ra
7. U-ni-verse	U-ni-ver-so
8. Ex-er-cise	E-jer-ci-cio
9. A-ni-mals	A-ni-ma-les
10. But-ter-fly	Ma-ri-po-sa
11. Fes-ti-val	Fes-ti-val
12. Sat-el-lite	Sa-té-li-te
13. Tel-e-phone	Te-lé-fo-no
14. Di-no-saur	Di-no-sau-rio
15. Vi-ta-min	Vi-ta-mi-na
16. Me-xi-co	Mé-xi-co
17. Kan-ga-roo	Can-gu-ro
18. E-ne-my	E-ne-mi-go
19. Sat-ur-day	Sá-ba-do
20. Va-ca-tion	Va-ca-ción
21. Com-pu-ter	Com-pu-ta-do-ra
22. Rec-tan-gle	Rec-tán-gu-lo
23. Hur-ri-cane	Hu-ra-cán
24. Bas-ket-ball	Bás-quet-bol
25. To-ma-toes	To-ma-tes
26. Go-ril-la	Go-ri-la
27. Fa-mi-ly	Fa-mi-lia
28. Wa-ter-fall	Cas-ca-da
29. Pre-si-dent	Pre-si-den-te
30. Tri-an-gle	Trián-gu-lo

Appendix G

Scoring sheet used by experimenter

G1

Speech Intelligibility Scoring Sheet		Speech Intelligibility Scoring Sheet	
Date:		Date:	
Target Word (English)	Production	Target Word (Spanish)	production
Banana		Platano	
Elephant		Elefante	
Magazine		Revista	
Discover		Descubrir	
Telescope		Telescopio	
Calculator		Calculadora	
Universe		Universo	
Exercise		Ejercicio	
Animals		Animales	
Butterfly		Mariposa	
Festival		Festival	
Satellite		Satelite	
Telephone		Telefono	
Dinosaur		Dinosaurio	
Vitamin		Vitamina	
Mexico		Mexico	
Kangaroo		Canguro	
Enemy		Enemigo	
Saturday		Sabado	
Vacation		Vacacion	
Computer		Computadora	
Rectangle		Rectangulo	
Hurricane		Huracan	
Basketball		Basquetbol	
Tomatoes		Tomates	
Gorilla		Gorila	
Family		Familia	
Waterfall		Cascada	
President		Presidente	
Triangle		Triangulo	

Appendix H

All phrases used for /Intɛli/

H1

1. Ate a banana	1. Comí un plátano
2. Saw an elephant	2. Vi un elefante
3. This magazine	3. Esta revista
4. You discover books	4. Tu descubres libros
5. The gray telescope	5. El telescopio gris
6. My calculator	6. Mi calculadora
7. One universe	7. Un universo
8. I exercise	8. Yo ejercicio
9. The animals	9. Los animales
10. A blue butterfly	10. Una mariposa azul
11. A grand festival	11. Un gran festival
12. Use the satellite	12. Usar el satélite
13. A telephone	13. Un teléfono
14. A green dinosaur	14. Un verde dinosaurio
15. Vitamin D is	15. Vitamina D es
16. live in Mexico	16. vive en México
17. brown kangaroo	17. canguro café
18. mean enemy	18. enemigo malo
19. love Saturday	19. amo sábado
20. short vacation	20. corta vacación
21. pink computer	21. computadora rosa
22. draw a rectangle	22. dibujar un rectángulo
23. the hurricane	23. el huracán
24. play basketball	24. jugar básquetbol
25. red tomatoes	25. tomates rojos
26. black gorilla	26. gorila negro
27. love my family	27. amo a mi familia
28. a tall waterfall	28. alta cascada
29. which president	29.cual presidente
30. small triangle	30. triangulo chico

Appendix I

All sentences used for /Intɛli/

I1

1. Today we will eat a banana.	1. Hoy vamos a comer un plátano.
2. I saw a big elephant.	2. Vi a un elefante grande.
3. I saw this magazine once.	3. Yo eh visto esa revista una vez.
4. Let's discover a new room.	4. Vamos a descubrir un nuevo cuarto.
5. This is a new telescope.	5. Este es un nuevo telescopio.
6. I have one calculator.	6. Yo tengo una calculadora.
7. My dogs' name is universe.	7. El nombre de mi perro es universo.
8. I exercise for an hour at the park.	8. Yo ejercicio por una hora en el parque.
9. I only like small animals.	9. Nomas me gustan los animales grandes.
10. My butterfly flew away.	10. Mi mariposa se voló.
11. The music festival was fun.	11. El festival de música fue divertido.
12. Our satellite is in space.	12. Nuestro satélite esta en el espacio.
13. My telephone has a loud ring.	13. Mi teléfono tiene un timbre fuerte.
14. A dinosaur runs fast.	14. Un dinosaurio corre rápido.
15. Vitamin D is good for you.	15. Vitamina D es bueno para ti.
16. Mexico is a country.	16. México es un país.
17. I have seen a kangaroo.	17. Yo he visto un canguro.
18. He is my enemy.	18. El es mi enemigo.
19. I watch movies on Saturday.	19. Veo películas los sábados.
20. My winter vacation is over.	20. Mis vacaciones de invierno han acabado.
21. What a small computer.	21. Que chica computadora.
22. Your room is a rectangle.	22. Tu cuarto es un rectángulo.
23. A hurricane is coming.	23. Un huracán va ah venir.
24. Let's play basketball.	24. Vamos a jugar básquetbol.
25. I want my tomatoes sliced.	25. Quiero mis tomates partidos.
26. The gorilla has a name, Bob.	26. El gorila tiene un nombre, Bob.

Appendix J

All sentences used for /Intɛli/ con't.

J1

27. They are a nice family.	27. Son una buena familia.
28. My mom has not seen a waterfall.	28. Mi mamá no ah visto una cascada
29. The president will speak today.	29. El presidente hablará hoy.
30. A triangle has three sides.	30. Un triángulo tiene tres lados.

Appendix K

All daily assessment logs for each therapy session with A.P.G

K1

Session 1(12/13/10): Baseline data collection. When A.P.G. was presented with the pictures for baseline data collection she was encouraged to verbalize and label the item pointed to. Experimenter used the phrase, "dime que es" (tell me what it is) to elicit verbalization and score A.P.G's production. Baseline was conducted three times throughout the therapy session and in between data collection a card game (UNO®) was played in which both the experimenter and participant verbalized the color and the number that appeared. A.P.G's verbalization of the presented pictures was unintelligible but on the last presentation of the visuals she managed to produced, "maposa" (butterfly). It was understood and counted correct by the experimenter. Participant demonstrated knowledge of primary colors in English when playing "UNO" and she switched between Spanish and English when she verbalized the numbers. A.P.G used gestures with speech-like vocalization to communicate during spontaneous speech, but was perceived as unintelligible.

Session 2 (12/15/10): /Intɛli/'s features were explained by the experimenter using simple sentences, "con este botón se puede ver el video y escuchar la palabra" (with this button you can see the video and hear the word). A.P.G was handed the mouse and was encouraged to click on the different icons to become familiarized with the features.

The Spanish version of /Intɛli/ was used for all presented multisyllabic words. Each syllable for the targeted word was addressed individually and it appeared that speech intelligibility improved with the increased drilling. Participant demonstrated understanding of therapy methods. A.P.G was given the mouse and with every presented word she first clicked on

"video" to engaging with the visual and auditory production of the entire target word. Participant watched the video and then immediately repeated the production and engaged with portions of the modified eight step continuum. A.P.G's low speech intelligibility percent might have been due to the first exposure to /Intɛli/ and the portions of the modified eight step continuum.

Session 3(12/17/10): Participant made minimal gains with her speech intelligibility, which may have been due to her constant sneezing and coughing that occurred throughout the session. However, the participant demonstrated improvement of speech intelligibility from baseline with the word "mariposa" (butterfly) in which, she verbalized the second syllable /ri/. Participant continued to engage with the use of /Intɛli/ by clicking on, "video" (word production) and "voltear" (displays all syllables). A.P.G smiled when asked to record the targeted word and appeared to enjoy using the microphone.

Session 4 (12/20/10): In this session there was an increase in the number of target words presented. Which may have been due to two main factors: (1) A.P.G. demonstrated an increase in speech intelligibility, through the use of immediate feedback and experimenter's reinforcement of target production. Therefore, the presentation of words continued. (2) A.P.G at times demonstrated frustration when asked to compare her recording of targeted multisyllabic word with /Intɛli/'s video-audio production. Therefore, to reduce frustration and increase motivation the experimenter moved on to the next multisyllabic word and continued providing therapy. The advancement to another word was used sparingly to not form an association

between the exhibition of frustration and the presentation of another word to avoid repetition and drilling of the targeted word.

Throughout the session the participant was provided with immediate feedback. The experimenter replayed A.P.G's recording, then /Intɛli/'s video-audio production of targeted word; followed by the question, "suena igual?", "se oye igual" and/or "se escucha igual" (all meaning, does it sound the same?). When A.P.G answered no, the experimenter continued drilling each syllable again until she demonstrated intelligible verbal production of the targeted word. Participant became engaged with /Intɛli/ when she was given the mouse and clicked on the "video" icon, then repeated the targeted stimuli. Experimenter reinforced the speech production by modeling the target stimuli for participant after /Intɛli/'s usage. The experimenter also observed that the participant demonstrated an increase with the letter sound correspondence, in Spanish. When the experimenter clicked on the targeted syllable participant began verbalizing the initial phoneme.

When a disagreement arose between participant and experimenter regarding perceptual judgment of the replayed verbal production, then the experimenter replayed the video-audio production and explained why the productions were not similar. She demonstrated understanding by nodding in agreement and each syllable was then drilled followed by a new recording of the targeted word. Once again the participant was asked to judge her verbal production of the recorded word and at times with the second recording she demonstrated frustration with the targeted word and abruptly answered "si" (yes) before the question, "se oye igual?" (does this sound the same) was asked. When this occurred the experimenter did not progress to a new word, instead asked A.P.G to listen carefully to the two productions (/Intɛli/ and her recording) and answer appropriately. When she listened and answered then

experimenter gave A.P.G the mouse and had her click on "next" for another word to be presented.

Session 5 (12/21/10): The number of targeted words was kept at eight as in the previous session for two reasons: (1) that was the maximum number of targeted words that could be presented within an hour session. (2) minimal gains had been demonstrated, therefore to reduce frustration and increase success the number was kept constant. A.P.G demonstrated increased speech intelligibility with the presented target words. It may have been due to the increased repetitions of each syllable of the target word through the use of video-audio productions and the experimenter's consistent modeling.

She demonstrated greater familiarity with /Intɛli/'s features, with the drilling routine for each syllable, and the use of Praat software. A.P.G recorded her verbal productions and immediately after she clicked the playback button to hear her production. A.P.G. then clicked the video-audio production. She may have done this for a number of reasons including: (1) she wanted to compare (2) she knew it was incorrect and wanted to hear and view the production again or (3) she associated it as part of the routine for therapy. The experimenter then explained the purpose of replaying her productions and /Intɛli/'s. A.P.G's overall verbal production of targeted words were perceptually perceived to be slow and rigid by the experimenter (may have been due to long pauses between each syllable production).

MIT was incorporated towards the end of the session since she demonstrated pacing of targeted multisyllabic words (increased pause time between syllable productions). The experimenter first explained and demonstrated hand tapping with simultaneous verbal production. Then the experimenter gently took hold of A.P.G's left hand and placed it over the

experimenter's right hand (so they were face to face) and tapped in a rhythm. When she demonstrated understand of tapping then simultaneous verbal productions were incorporated, beginning with the first syllable of targeted multisyllabic word. She demonstrated frustration when syllables were incorporated to the hand tapping, and removed her hand from experimenters. The experimenter did not persist with the continuation of MIT, because the session was ending and it was the first time to have been attempted.

A.P.G's speech intelligibility was perceived to have increased in comparison to the previous session. The experimented observed that when a multisyllabic word was drilled in the previous session the participant demonstrated an increase with the pace (shortened pause time between syllables) and flow of that targeted word drilled word for example, "familia" (family), (refer to appendix F1 for target words).

Session 6 (12/22/10): This was the last therapy session for A.P.G before she had a week off and went on vacation for the holidays. A.P.G. coughed and yawned throughout the session and exhibited decreased motivation. The participant was distracted by her surroundings: the microphone, her shoe, and the small plush monkey that she brought. The experimenter moved the microphone and plush monkey out of her sight to minimize the distractions and redirected her to the computer screen. The participant was handed the mouse to maintain her engagement with /Intɛli/ and continued with therapy. A.P.G. maintained a constant 50% speech intelligibility which may have been due to her continuous coughing and yawing as well as her decreased motivation. Probing took place at the phrase level, and no generalization appeared to occur.

Session 7 (1/3/11): This was the participant's first session from her week vacation. A.P.G. yawned throughout the session which may have been due to her waking up from a nap before therapy as reported by her father. Four out of the eight words were presented for the first time, "elefante" (elephant), "ejercicio" (exercise), "presidente" (president), and "triangulo" (triangle), and only one was perceived as intelligible, "elefante" (elephant). A.P.G also tried "triangulo" (triangle) in English and it was not perceived as intelligible by the experimenter. The aforementioned external factors may have attributed the decrease in speech intelligibility.

Session 8 (1/5/11): Today was A.P.G.'s first day of school after their winter break and appeared to be tired by yawing continuously at the beginning of the session. The experimenter attempted to motivate the participant by working on two words and once completed (drilled, recorded, and judged) then played a card game "UNO". The pattern continued until eight words were completed (all steps completed). The reward to play the card game appeared to have motivated the participant to work on the presented words. In changing the consequence to playing a card game after every two targeted words, is a factor that could be considered impactful for her increased speech intelligibility.

She appeared to have learned the functions of the flags, switching between English and Spanish and clicking on the video-audio for the word production. A.P.G switched between languages and appeared to judge the difficulty of the target word by the number of syllables it contained in either language. For example, "cal-cu-la-do-ra" (cal-cu-la-tor) was one of the target words A.P.G clicked on "video" (video-audio of target word) in each language, she shook her head and said "no" simultaneously then clicked on "next" for another word to appear. The experimenter noted that if the targeted word contained more than three or four syllables, in either

language then the participant would immediately click on “next”. However, the experimenter urged A.P.G to attempt the difficult words and she attempted two words with five syllables, “computadora” (computer) and “calculadora” (calculator). The five syllable words recorded were perceptually judged to be unintelligible by experimenter and participant. When A.P.G perceptually judged her recording of three syllable target words to be similar to the video-audio productions she smiled and hugged the experimenter.

Session 9 (1/7/11): At the beginning of the therapy session the participant yawned, rubbed her eyes, and constantly needed to be redirected to the task. The reward system of working on two words and then participating in a game was implemented to motivate A.P.G. The participant attempted two words in English, “triangle”, and “Saturday” and there was also an increase in the number of repetitions as compared to multisyllabic words attempted in Spanish. Both the reward system and constant repetitions with /Intɛli/ and experimenter may have attributed to the increased speech intelligibility at the word level. Probing took place at the phrase level and generalization of speech intelligibility was not demonstrated.

Session 10 (1/17/11): The participant returned to therapy after a week off. Father mentioned that he picked her up from school, because she was now taking drumming lessons. A.P.G yawned, looked away, and was constantly distracted with her dog bag, demonstrated decreased attention with using /Intɛli/, even after her dog bag was placed out of sight. She demonstrated decreased motivation by constantly touching her face, looking down, and making whining noises. She demonstrated continued familiarity with the program and the routine that had been established throughout the sessions (video-audio production, experimenter modeling). The demands were

increased by two words, since the previous session she reached 75% speech intelligibility, out of eight words six were scored as intelligible.

Session 11(1/19/11): The participant demonstrated frustration and lack of motivation through gestures, covered her eyes and also made whining noises that sounded like "no". She appeared tired, continuously yawned and closed her eyes. A.P.G's participation in the therapy session appeared to have decreased as compared to previous sessions. When asked to verbalize the word she produced unintelligible utterances and kept her eyes closed. Participant clicked on the video-audio production, but did not look at the experimenter for further feedback. These behaviors may have contributed to her consistent performance at 50% speech intelligibility along with the lack of motivation.

Session 12 (1/24/11): In comparison to the previous therapy session A.P.G appeared to be motivated, she smiled while she clicked on the video-audio icon and repeated the target stimulus (syllable or word). The participant looked at the experimenter for further modeling and she verbalized instantly. The experimenter turned over all the syllables and asked A.P.G, "¿Qué palabra es esta?" (What is this word) before any /Intɛli/ features were clicked and she said "facil" and responded intelligibly, "enemigo" (enemy), and "tomates" (tomatoes). The picture representing the word might have helped in remembering the targeted words and/or those targeted words may have become sight words. The recordings were replayed, compared to the video-audio productions from /Intɛli/, she was asked to judge her verbal production. When A.P.G agreed her verbal production was intelligible, she smiled and hugged experimenter.

A.P.G's speech intelligibility increased and the rate of verbal production was perceived to increase in naturalness.

Change with experimenters

Session 13(2/9/11): During this therapy session, the experimenter worked on the following words: "cascada", "calculadora", and "huracan". The experimenter utilized the software and practiced the production of each syllable for each word utilizing auditory and visual feedback (audio and video recordings). When A.P.G. demonstrated difficulty producing a syllable or word, the experimenter provided modeling and gestural cueing strategies in order to reinforce correct and intelligible production of words. When A.P.G demonstrated relatively intelligible productions of the words, she was then allowed to record herself producing the word. The participant was only given one opportunity to record the word after she had learned how to produce it and this production was utilized in order to measure speech intelligibility. A.P.G actively participated in the production of the first two words ("cascada" and "calculadora"), but began to close her eyes, yawn, and doze off once the word "huracan" came up. Since the participant was no longer engaged in the activity, experimenter did not continue practicing on the word "huracan" and instead had participant engage in another activity.

Session 14 (2/14/11): A.P.G's spontaneous productions mainly consisted of monosyllabic and bisyllabic words. The words that are produced intelligibly appear to be those that the client knows by memory.

The participant exhibits greater difficulty with multisyllabic words and does not produce them frequently in conversation. A.P.G exhibited significant difficulty producing unfamiliar multisyllabic words in today's therapy session.

It remains uncertain whether the participant can spontaneously produce words that are drilled during therapy (words other than those known by rote memory). When participant was shown a picture of a triangle ("triangulo") she did not produce it spontaneously despite the word being drilled utilizing the software program. It seems that the participant benefits from auditory and visual feedback, but struggles when word is to be produced spontaneously.

Self-correction during use of software may be a good indicator that A.P.G is beginning to memorize word and realizes that word is being produced incorrectly.

A.P.G. rarely attempts to utilize two word phrases and typically responded to questions with single words. Instances where she attempted to communicate more than one single word resulted in unintelligible utterances.

Session 15 (2/16/11): /Intɛli/ was also utilized during this session in order to probe for two-word phrases. During this therapy session, the experimenter worked on the following phrases: "alta cascada", "los animals", and "un telefono". The experimenter utilized the software and practiced the production of each word utilizing auditory and visual feedback (audio and video recordings). The A.P.G. did not spontaneously identify the words that were visually presented on the computer screen, so the experimenter provided a model. When A.P.G. demonstrated difficulty producing a syllable or word, the experimenter provided modeling, miming, and gestural cueing strategies in order to reinforce correct and intelligible production of words and phrases. As the experimenter and A.P.G. were practicing words and phrases, A.P.G demonstrated inconsistent

productions of each of the words/phrases. The experimenter broke down each word into its syllables as the participant imitated productions. A.P.G seemed to benefit most from imitating the experimenter's productions. Once the experimenter began miming words/syllables, A.P.G. began exhibiting difficulty and inconsistent productions.

It appears that A.P.G. struggles more when there is a greater demand for her to either produce words consisting of 3+ syllables (as demonstrated in previous sessions) or in producing two-word phrases. When A.P.G. demonstrated relatively intelligible productions of the words/phrases, she was then allowed to record herself producing the phrase. A.P.G was only given one opportunity to record the phrase after she had learned how to produce it and this production was utilized in order to measure speech intelligibility. At times, during use of /Intɛli/, she engaged in self-correction when practicing a word or syllable

Session 16 (2/21/1): Participant exhibits greater difficulty with multisyllabic words and does not produce them frequently in conversation. A.P.G was not actively engaged in today's therapy session.

It remains uncertain whether A.P.G. can spontaneously produce words that are drilled during therapy (words other than those known by rote memory). A.P.G. seems to benefit from experimenter's modeling, but begins to exhibit difficulty when experimenter only provides miming or gestural cues. A.P.G began to produce inconsistent production of target words once the experimenter removed verbal modeling (direct imitation and simultaneous production) and only presented the participant with miming and gestural cues. When experimenter asked participant, "what were words that we had practiced?", A.P.G. did not spontaneously produce

words which leads experimenter to question whether the participant will spontaneously produce target words at a later time.

Session 17 (2/23/11): /Intɛli/ was also utilized during this session in order to target multisyllabic words. During this therapy session, the experimenter worked on the following words: "tomates," (tomatoes) "vacación," (vacation) and "Mexico". During today's session, A.P.G recognized a majority of the pictures displayed on the computer ("tomates" and "Mexico") and would either sound out some of the syllables that made up the word or would say the word that corresponded to the picture. If A.P.G. could not come up with the word simply by identifying the picture displayed on the computer, she would figure out what the word was when the first syllable of the word was shown to her (before the experimenter had to either provide her with auditory feedback or modeling/gestural cues). The experimenter utilized the software and practiced the production of each word utilizing auditory and visual feedback (audio and video recordings). When shown a picture representation of the target word, A.P.G attempted to produce word. This demonstrated she recognized the picture and was relatively familiar with the target word. A.P.G was aware of some of the sounds that make up the word. A.P.G. required auditory and visual feedback as well as modeling from the experimenter (particularly for the word "vacación").

Session 18 (2/28/11): During this therapy session, the experimenter worked on the following words: "dinosaur" and "descubrir" (discover). During today's session, A.P.G. did not readily recognize the pictures displayed on the computer screen and was not able to spontaneously produce the word or the syllables that made up any of the words. When shown the word "dinosaurio" (in Spanish), she opted to say the word in English (dinosaur). A.P.G immediately

grabbed the mouse and switched the word from Spanish to English. It is believed that she did this since the English word contains fewer syllables than Spanish word. The experimenter utilized /Intɛli/ and practiced the production of each word utilizing auditory and visual feedback (audio and video recordings). A.P.G. required auditory and visual feedback as well as modeling from the experimenter.

Session 19 (3/3/11): At the request of first experimenter A.P.G. was asked to verbalize the presented pictures: "tomates", "platano", "computadora", "dinosaurio", "triangulo", "gorila", "calculadora", "mariposa", "basquetbol", and "elefante". These pictures were words that have been practiced through the utilization of the software. Although this data was not gathered for the purposes of the present goals, this activity was utilized in order to determine whether the client could spontaneously produce the words for the pictures without any visual or auditory feedback or intervention from the experimenter. When shown the picture for "mariposa", she spontaneously produced /posa/. When shown the picture for "elefante," she produced /elafa/. When shown "basquetbol," she produced /batebol/. When shown "tomate," she produced /lamate/. When shown "gorila," she first produced "mono" and then produced "gorila." When shown "computadora," she produced /pumote/. A.P.G. was unable to spontaneously produce any of the words for the remaining pictures. Although A.P.G did not spontaneously produce many of the words, she did attempt to sound out syllables (even when the syllables did not correspond to the target word).

During this therapy session, the experimenter worked on the following words: "festival," "gorila", and "sabado" (Saturday). A.P.G. was able to produce the word "gorila" spontaneously after being shown the picture. A.P.G. did not readily recognize the other two pictures displayed

on the computer screen and could not spontaneously produce the word or the syllables that made up any of the words. The experimenter utilized the software and practiced the production of each word utilizing auditory and visual feedback (audio and video recordings). The participant required auditory and visual feedback as well as modeling from the experimenter.

Curriculum Vita

Esnire Abigail Gomez was born in El Paso, Texas, on the 10th of April 1987, the daughter of Alejandro Gomez and Sylvia Gomez. She graduated from W.H. Burges High School, El Paso, Texas in May 2005 with top ten percent honors, photo-editor of national winning publications (yearbook, newspaper, and literature magazine), and president of the national honor society chapter. In being part of these organizations she learned the value and importance of patience, teamwork, and meeting deadlines, which would later be vital in her pursuit of higher education. She entered the University of Texas at El Paso (UTEP) in August 2005. During her undergraduate studies in Speech-Language Pathology, she was employed in the Ysleta Independent School District (YISD) as a part-time Advancement Via Individual Determination (AVID) tutor. Esnire not only provided further mentorship to the students but through this, also confirmed her passion and joy in assisting individuals to the best of her abilities. Tutoring provided her with further determination to be successful in the speech-language pathology program. She looks forward to entering the non-academic lifestyle upon graduation in May 2011 from UTEP. However, it will not be long before she re-enters the world of academia in pursuit of her doctorate degree.

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