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A Model Of Treating Hyperfunctional Voice Disorders For School Age Children Within A Serious Gaming Environment

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A MODEL OF TREATING HYPERFUNCTIONAL VOICE DISORDERS
FOR SCHOOL AGE CHILDREN
WITHIN A SERIOUS GAMING ENVIRONMENT

by

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ABSTRACT

The purpose of the present study is to test the feasibility of implementing a video-game based intervention protocol as a means to improve therapy compliance in school age children with hyperfunctional voice disorders. Three levels of modification were made to an existing entertainment software program in order to implement the therapeutic protocol and test compatibility. The third level of modification included a two-phase quasi-experimental single subject design with a school age participant receiving the video game therapy protocol and traditional therapy for equal time. The independent variables for this study included the mode of voice therapy delivery (traditional vs. video game). The dependent variables included therapy compliance, perceptual evaluations and acoustic measures.

This study found that a purely entertainment video game can be implemented as a therapeutic protocol for a school age child diagnosed with a vocal pathology. Results illustrated no change in compliance with non-traditional therapy versus traditional therapy. However, perceptual measures improved post treatment for breathiness, strain and overall severity, as well as significant differences for mean amplitude. Discussion will focus on implications of employing video game based therapy and design of future studies.

In dedication to my father, Dennis Thomas King for influencing me to persevere in the face of challenges. You will always be a source of inspiration in my life.

ACKNOWLEDGMENTS

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LIST OF ACRONYMS

CAPE-V   Consensus Auditory-Perceptual Evaluation of Voice

IDEA   Individuals with Disabilities Education Act

LMRVT   Lessac-Madsen Resonant Voice Therapy

MDVP   Multi-Dimensional Voice Program Advanced

NHR   Noise to Harmonic ratio

PCM   Pulse-code modulation

pVHI   Pediatric Voice Handicap Index

SLP   Speech Language Pathologist

VAS   Visual analogue scale

VHI   Voice Handicap Index

CHAPTER ONE: INTRODUCTION

Strategies for treating children with hyperfunctional voice disorders historically have been derived directly from therapeutic strategies implemented for adults with voice disorders. These methods, and the theories they are based on, inherit many assumptions that are valid for adults. However, these assumptions are typically not valid when treating children with hyperfunctional voice disorders. For example, the differences that exist between the child and adult are more than just size alone; there are distinct structural and functional differences of the pediatric larynx that may impact the child's behavioral patterns and potentially hinder academic success. Moreover, a child's motivation, determination and interests are very different from adults. Therefore, it is not sufficient to merely adapt adult therapeutic strategies to children. As a result, speech language pathologists (SLPs) who are providing treatment to children with deviant vocal behaviors, need to devise strategies that consider their physiological and behavioral differences as well as motivation for vocal improvement.

Treatment of hyperfunctional voice disorders in the pediatric population is not a new notion but is gaining popularity in clinical and research environments. In the past, clinical and anecdotal literature has suggested, "a child will outgrow vocal nodules;" requiring little to no treatment. However, more recently researchers have stated that children rarely outgrow a laryngeal disorder due to the commonly reoccurring maladaptive behaviors that caused the phonotrauma (Powell, 1989; Wohl, 2005).

Since voice treatment can be very challenging and time consuming with a pediatric patient, the success of therapy relies heavily on a patient's motivation and momentum to progress through the phases of therapy (Mori, 1999). There has been a trend in past scientific literature indicating that therapy for children with voice disorders typically fails because the

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children and parents are not compliant with therapeutic recommendations. In the worst case scenario the child never receives therapy, in other cases parents and children may not follow through with therapeutic recommendations. Therapy is often similar to homework and is negatively associated with numerous clinical visits. Other related problems might occur due to limited linguistic development, communication abilities and the need for family/parent support (Andrews & Summers, 2002). The outcome of voice therapy should focus on optimizing a child's voice production by implementing therapeutic procedures which overcome behaviors that are impeding the progress of treatment (Behrman & Orlikoff, 1997).

Many of the therapeutic activities currently available for pediatric patients with voice disorders have been generated to overcome motivational problems associated in a therapy session with a SLP, such as: board games, coloring activities, scenarios, role playing, computer games, etc. However, these activities cannot compete with the current entertainment technology on the market and fail to maintain the attention of the child at home. Therefore, development of interactive, competitive and realistic software applications for home based therapeutic purposes may provide the necessary stimulus needed to motivate pediatric patients. The purpose of this pilot study is to test the feasibility of implementing a model of voice therapy presented in a gaming environment as a means to improve voice quality and factors related to therapy compliance in school age children with voice disorders.

<div align="center">Therapeutic Application of Serious Gaming</div>

The success of voice therapy relies heavily on the techniques taught in the therapeutic session to generalize to the patient's natural setting through home based practice (Deal, McClain, Sudderth, 1976; Glaze, 1996). This can be a very challenging assignment for pediatric patients and their family members, due to the time and persistence it entails. During the therapeutic

session, the SLP provides consistent stimulation to the pediatric patient to keep him on task and motivated, though at home parents have the responsibility of reinforcing therapeutic practice and implementation of the appropriate behaviors (Glaze, 1996). The beginning stages of physiologic based voice therapy can be more demanding for the patient and the parent due to the establishment of compliance with specific tasks and the development of self monitoring of their vocal behaviors. Consequently, the use of serious gaming technology for home therapeutic applications can provide increased stimulation through animated graphics and competitive interactions, ultimately improving treatment and success in generalization.

The notion of using games, game scenarios, and game technology for efforts other than pure entertainment is well known. Previous research in speech therapy has shown the clinical effectiveness of using software applications for visual feedback with speech training (Ryalls, Michallet, & La Dorze, 1994). One such article used the SpeechViewer software program in therapy to facilitate desired behavior by providing visual and auditory biofeedback to the participant (Le Dorze, Dionne, Ryalls, & Julien, 1992). More recently, there have been a number of application areas for "serious gaming" including education, business and military training. Within the sphere of serious gaming, there is also a large body of work related to the use of games for rehabilitation and health and wellness. The use of video games as a therapeutic tool for pediatric patients has been a practice in several medical fields either to distract the patient from the repetitive tasks or to help engage them in more activity. One such study showed that video games can be attention or cognitive distracters to control nausea in pediatric cancer patients recovering from chemotherapy (Redd, Jacobsen, Die-Trill, Dermatis, McEvoy, & Holland, 1987). This study found video games to be a distracting task that helped to refocus the attention away from the nausea sensation due to the required cognitive and motor activity,

sustained involvement, and appeal to children (Redd et al., 1987).   Another study, which tested the behavioral outcomes of adolescent and young adults with malignancies, found that video-game intervention improved treatment adherence, self-efficacy and knowledge in those participants who underwent cancer therapy (Kato, Cole, Bradlyn, & Pollock, 2008). Video games can have a positive therapeutic benefit when motivating a patient to perform normal passive and repetitive movements (Griffiths, 2003).

While video games are currently used in voice and speech therapy programs, these games suffer from several limitations. Many of the therapy games currently on the market have bland graphical presentations and storylines, especially when compared to the current standards in the entertainment gaming industry. According to one study that surveyed 382 participants (aged 14 to 50 years) found that the success of video games can be a factor of multiple structural characteristics, such as: high degrees of graphical realism, realistic sound effects and speaking characters, rapid advancement through games, and winning and losing features (Wood, Griffiths, Chapell, & Davies, 2004). Furthermore, the current therapy games require specialized sound equipment for voice input and data collection that the practitioner must specially configure, and direct, real-time, quantitative performance measurement is not available. Finally, the practitioner must be physically located with the patient to determine whether the exercise was performed properly. Therefore, modifying a purely entertainment video game for use as a therapy protocol will help to overcome these limitations and enable full engagement of the participant to the therapy task.

<u>Incidence and Prevalence of Voice Disorders in Children</u>

According to Kahane and Mayo, 45 to 80% of childhood dysphonias are the result of phonotrauma (Kahane & Mayo, 1989). Hoarseness is a common symptom for many of the

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different vocal pathologies (Silverman & Zimmer, 1974). The incidence of hoarseness in school-aged children is significant and has the potential to affect a child's oral communication, class participation, academic and extracurricular achievement (Andrews, 2002; Ruddy & Sapienza, 2004). The incidence of chronic hoarseness is significantly higher in school age children (kindergarten to seventh grade) compared to adults (Silverman & Zimmer, 1974). The majority of hoarseness in the school age children occurs around third grade (46%) and the incidence slowly declines (Silverman & Zimmer, 1974). However, due to increased extracurricular activities and associated voice use, the incidence of voice disorders in middle school children may be higher than previously expected at 8.3% (Kahane & Mayo, 1989). Research has shown that voice disorders may persist or reoccur in children over a five-year period of time (Powell, Filter, & Williams, 1989).

Prevalence studies of pediatric voice disorders are necessary in order to develop sound theoretical models of the cause and correlates of speech disorders (Nair, Clegg, & Patel, 1986). A number of factors have contributed to the differences found in the results of these studies such as age of participants, qualifications of evaluators, and methods used. One study evaluated 745 children in the public school that ranged from 7 to 16 years in age; the authors found the overall prevalence of vocal nodules to be 16.9%, as well as 30.2% if pre nodular lesions were found (Kilic, Okur, Yildirim, & Guzelsoy, 2004). Findings also indicated that boys have a higher likelihood of developing vocal nodules then girls. Another study of 2,445 African-Americans and European-American preschool children ranging from 2 to 6 years of age were evaluated by classroom teachers, visiting speech language pathologists (SLP) and parent surveys. Results suggested that 3.9% of preschoolers observed presented with a voice disorder characterized by hoarseness (Duff, Proctor, & Yairi, 2004). These findings suggest discrepancies in exactly how

many children are affected by voice disorders; however, it clearly defines that there is a problem and that early identification, prevention and treatment are necessary.

<center>Behavioral and Psychological Effects of Pediatric Voice Disorders</center>

Research varies considerably in prevalence of pediatric voice disorders, however it is apparent that phonotrauma in children can lead to emotional or behavioral disorders (Green, 1989). Contrarily, a child with abnormal emotional or behavior disorders could be indirectly having phonotraumic events, due to yelling, screaming, whining, crying, coughing, etc. The latter, occurs due to the unpredictable changes to the child's voice when upset or struggling to maintain intelligibility. The perception of abnormal voice production by the pediatric patients can also have negative psychological and/or behavioral effects. This may begin with the poor habits that cause excessive effort and tension during vocalization, and then leads to misdirected and inefficient communication. Children may have a tendency to develop aggressive, distractive, disturbed peer relations, and immature behavioral characteristics later on (Green, 1989). Findings have also found that peers negatively stereotype personality and physical appearance, which can impede in the disordered child's ability to mainstream into society (Lass, Rusello, Stout, & Hoffman, 1991). Furthermore, these vocal behaviors may result in a negative listener reaction and/or perception of thoughts can be distorted.

Children who develop vocal fold nodules have historically been considered to be talkative and loud speakers, who tend to yell and scream (Toohill, 1975). However, some researchers have found there to be no typical behavioral features (Roy, Holt, Redmond, & Muntz, 2005). Studies have found that children with vocal nodules have a different social component, which is associated with their voice use, meaning that they have more friends, spend increased amount of time with friends, and are involved in more extracurricular organizations

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(Roy, 2005). No matter what the etiology is, these factors could lead to increases in the severity of a vocal pathology requiring unique therapy techniques in order to facilitate the therapeutic needs of the patient.

<center>Effects on Academic Performance</center>

Many children are treated in the school system by speech language pathologist for voice disorders under the Individuals with Disabilities Education Act (IDEA). This act is a federal law that ensures that all children receive services if a specific learning disability causes a negative effect to a student's academic performance. Disordered voices have the potential to negatively affect oral communication and cause changes in the pitch, loudness and vocal quality of the child, which may limit intelligibility and ability to effectively communicate. Sixty-six percent of 282 regular classroom teachers, special educators, administrators and instructors of physical education, art, music, and library science who responded to questionnaires regarding their perspective of a child currently enrolled or who had been enrolled in speech therapy, stated that a communication disorder has adverse effects on a child's educational performance (Bennett & Runyan, 1982). Forty percent of teachers also indicated that they believed both academic and social skills were affected due to the abnormal differences from their peers. Even though, there is no definitive evidence of any research that has studied the correlation between poor academic performance and vocal pathologies, it is assumed that problems with vocal performance will cause problems in the classroom (Bennett & Runyan, 1982). A child's educational performance descends due to a voice disorder and under federal legislation, this would make them eligible for services in the schools under the guidelines of IDEA (Ruddy & Sapienza, 2004). IDEA was established to provide early intervention, special education, and related services to children with disabilities (Congress, 1997). According to the Senate and House of Representatives, a disability

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should in no way diminish the right of an individual to participate in or contribute to society (Congress, 1997). Thus, if oral communication is used during academic classroom activities and peer situations a child with phonotrauma might feel embarrassed or fear sounding unintelligible and will not contribute to the intended lesson. These behaviors could potentially limit participation in regular classroom discussions, due to reluctance to participate because of negative attention from surrounding environments (Ruddy & Sapienza, 2004).

The patterns exhibited by children with social behaviors, are similar to the way children with phonotraumatic voices are neglected or ignored by their peers (Andrews & Summers, 2002). Educational deficits can be caused by strained voices, compensation, restricted vocal options, and inadequate understanding of pragmatics (Andrews & Summers, 2002). Teachers also believe that speech therapy can improve academic performance and social interactions with both peers and adults (Bennett & Runyan, 1982). These findings indicate that there are noticeable differences between a vocal disordered child's pragmatic abilities.

<u>Anatomy of the Pediatric Larynx</u>

The anatomical configuration of the pediatric larynx is different from those of the adult in several ways. The most prominent is the size and shape of the different anatomical figures. At birth the size of the larynx is only 1/3 the size of the adult larynx at 2.5 to 3.0 mm in length and will not grow into the full adult size until puberty (Fried, 1996; Sapienza, Ruddy, & Baker, 2007). Also, the location of the pediatric larynx is considerably higher than the adult larynx and the cricoid cartilage is thicker and more V shaped (Fried, 1996; Myer, Cotton, & Shott, 1995). The larger cricoid cartilage helps to hold the enlarged arytenoids in the pediatric larynges that are in close proximity due to their size (Myer, et al., 1995). The pediatric epiglottis reaches its mature shape at three years of age (Pohunek, 2004). Furthermore, the physical development of

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the smaller structure of the larynx is noticeable in the pitch of the child's voice. These changes become increasingly more evident, when the male and female voices begin to change during puberty. Prior to ten years of age both sexes have similar lengths of vocal folds, around 6 to 8 mm (Bluestone et al., 2003). The vocal folds are also one-half cartilaginous and slope inferiorly from posterior to anterior (Fried, 1996). Between ten and twenty years old, the female vocal folds increase by 4.2 mm and males increase by 10.9mm (Bluestone et al., 2003). The cartilaginous portion of the vocal folds also increases with age, and is necessary in order to protect the folds from edema during phonation (Bluestone et al., 2003). The ratio of membranous and cartilaginous portions in the vocal folds is 1.5 mm in newborns compared to 4.0mm in adult woman and 5.5mm in adult males (Bluestone et al., 2003). The five distinct layered structures of the vocal folds do not begin to formulate until after four years old (Bluestone, et al., 2003). This increases the thickness of the lamina propria and it can act as a protective agent in order to shield from the over active vocal folds found in children (Bluestone, et al., 2003). These structural changes in vocal folds are most distinguishable in the pitch change of the pediatric voice. At birth the infants cry is about 500 Hz and decreases by one-half around the age of 8 to 10 years old (Bluestone et al., 2003).

Another difference between the pediatric and adult patient is the smaller oral cavity, with a normal size tongue and a retruded mandible (Fried, 1996). This proportional difference can help to push the epiglottis caudally from the nasopharynx and palate (Fried, 1996). The configuration of the pediatric larynx is curved from the oral cavity to the hypopharnx and on to the larynx into the trachea (Fried, 1996). Certain distinctions which differentiate the pediatric larynx can generate more effort in order to sustain respiration, such as: the location of the larynx during birth facilitates spontaneous breathing and the connective tissue that creates the pediatric

airway is much more pliable than the adult form (Fried, 1996). This can have effects on

respiration, due to the greater influence on the normal pressure generated during respiration.

Research has found that differences in speech breathing in pre-pubescence could also be related

to the smaller composition of the pediatric body and effect the lung, rib cage and abdominal

volume (Hoit, Hixon, Watson, & Morgan, 1990). Specifically, seven year old children tend to

initiate and terminate larger volumes of air to take advantage of the higher expiratory recoil

pressure. Therefore, management considerations should be made accordingly in order to account

for a child's natural maturational changes in speech breathing. For instance, a younger child

could produce fewer syllables per breath group, as well as expend larger quantities of air per

breath group.

<p align="center">Definition of Pediatric Voice Disorders</p>

A voice disorder can include deviant vocal behaviors related to the pitch, loudness and/or

overall quality of a child's voice. Some of the common voice disorders seen in school age

children may occur from functional, organic or neurologic processes. Functional voice

disorders, such as edema, nodules and polyps are due to increased phonatory effort. Organic

voice disorders, such as papilloma, laryngeal pharyngeal reflux, granuloma or contact ulcers may

require therapy to eliminate phonotruamatic behavior, which developed as a compensatory

technique due to the increase in mass of the vocal folds. Neurologic voice disorders which have

secondary voice components include: cerebral palsy and muscular dystrophy which effect motor

speech control. Other structural disorders can include stenosis, congenital or acquired webs,

cysts, infection, or postsurgical upper airway anomalies.

The majority of voice disorders occurring in children are due to hyperfunctional voice

behaviors (Ramig & Verdolini, 1998). When inflammation occurs from phonotrauma it hinders

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the closure of the vocal fold, vibratory pattern, and results in changes to pitch loudness and quality. The excess in laryngeal muscle tension, force and constriction causes a mechanical breakdown during speech. Hyperfunctional voice disorders adduct the false vocal folds, compress the aryteniod cartilages into the epiglottis, and can have rapid or complete adduction of the vocal folds. Common complaints can include vocal fatigue, throat discomfort, and impaired voice quality (Freeman & Fawcus, 2000). Pathological changes can also occur due to the excess muscle tension and exertion, such as: edema, inflammation, nodules, polyps or hemorrhages.

<div align="center">Common Vocal Pathologies that occur with Pediatric</div>

One of the most common vocal pathologies in children are nodules, it is estimated that approximately 1% of children may develop vocal nodules at some point in their life. Therefore, many children will be impacted by vocal disorders which can possibly alter their quality of life. Nodules are benign vocal fold lesions that occur due to inflammation of the superficial layer of the lamina propria (Stemple, Glaze, & Klaben, 2000). Nodules are located on the vocal folds at the point of greatest amplitude of vibration, which is on the medial edge between the anterior one third and posterior two thirds of the true vocal folds (Stemple et al., 2000). Their appearance is gelatinous and floppy, with the squamous epithelium looking normal (Stemple et al., 2000). Nodules usually occur bilaterally and their size will vary (Stemple et al., 2000). The lesion that forms will increase the mass and stiffness of the vocal fold, possibly causing changes in vibratory patterns (Stemple et al., 2000). These changes will result in dysphonia which will cause symptoms of a raspy, breathy voice, and result in increased muscle tension. Vocal nodules are predominantly seen in boys and frequently occurs in children between the ages of 5 and 10 (Toohill, 1975) The gold standard for treatment of vocal nodules is vocal rehabilitation therapy, in which therapy focuses on the specific behaviors that are the cause of the problem and proper

management and voice use is taught. Surgery is rarely considered due to the invasiveness of the procedure and the notion that this pathology is formed by phonotraumatic behaviors which need to be eliminated and/or modified (Wohl, 2005).

Another vocal pathology that occurs from phonotrauma but less often than nodules is the development of vocal polyps. These lesions are fluid-filled and develop in the middle one-third of the superficial layer of the lamina propria (Stemple et al., 2000). Polyps can have a sudden onset and can increase rapidly in size, due to their active blood supply. Polyps usually occur unilaterally and can present with two different shapes: sessile which is blisterlike or pedunculated which looks similar to a stalk. Symptoms vary due to where the lesion is located and how much glottal closure is affected. The mass of the vocal folds will increase and depending on other problems, such as edema or a hemorrhagic blood vessel, the stiffness could increase as well. A secondary lesion can occur on the other vocal fold due to continued phonotrauma and reaction to the polyp on the other fold. Polyps are usually treated by surgery and voice rehabilitation therapy to eliminate the poor vocal behaviors.

<div align="center">Common Traditional Therapy Techniques</div>

Clinicians use a variety of therapy approaches to treat hyperfunctional voice disorders in children. Currently, exercises that are being used in voice therapy protocols for children rely on passive and repetitive movements. The most common therapy techniques performed on pediatric patients pertain to voice conservation, direct vocal exercises, and principles of behavior modification (Glaze, 1996).

In conjunction with treatment, the patient and family members are educated regarding anatomy and physiology of the larynx and proper hygiene. Images are shown to the patient and family, which compare a healthy larynx with the current condition of the patients' larynx.

Discussions also elaborate on how respiration, phonation and resonance can affect how the patients' voice is produced.

In addition, voice conservation is also typically done in conjunction with another therapy approach due to the high correlation of vocal misuse with hyperfunctional voice disorders. Specific phonotramatic events may include: improper hydration, abusive non-speech and speech habits, poor breath support, excessive stress or tension, inappropriate or unresolved coping mechanisms for negative emotions, and limited vocal fold recovery time (Glaze, 1996). Each of these situations will be discussed with the patient and the parent in order to facilitate higher productivity with voice therapy. Strategies also will be implemented to limit the amount of phonotramatic occurrences.

Resonance therapy is widely accepted throughout the voice therapy literature for treating vocal hyperfunction in the adult population (Verdolini-Marston, Burke, Lessac, Glaze, & Caldwell, 1995; Chen, Huang, & Chang, 2003; Roy, Weinrich, Gray, Tanner, Stemple & Sapienza, 2003) and gaining popularity as a treatment modality in the pediatric population (Glaze 1996; Verdolini, Hersan, & Kessler; Stemple, 2000). Researchers have found that this technique transfers energy from the glottis to the lips, enabling the tissue on the facial regions to take the brunt of the vibration (Titze, 2004). There are numerous iterations of resonant voice therapy (i.e. Vocal Focus, Frontal Focus, and most current, Lessac Madson Resonant Voice Therapy). The techniques and exercises consist of a series of systematic voice manipulations typically beginning on more resonant sounds (i.e. /m/ and /n/) designed to improve respiration, phonation and resonance. Resonant voice will be implemented while proceeding through a hierarchy of stages starting with a sustained phonation (i.e. humming) and progressing through spontaneous speech. The patient will progress through these stages by implementing the

techniques taught in voice therapy sessions to their home based practice and eventually into daily activity.

Due to the age and attention span of the pediatric patient, many SLP's will use interactive games and creative tasks to help engage the child during therapy. These activities can be beneficial and allow more productivity during a session. Supplemental materials are available to SLP's and parents that target specific symptoms, however they are meant to enhance the therapy protocol and not take the place of shaping the vocal production.

The current research study implemented an eclectic therapy approach, which involves the use of multiple behavioral therapy modalities such as, hygienic, symptomatic and physiologic voice strategies specific to the participant in order to reduce vocal hyperfunction and compensatory vocal behavior (Stemple, 2000).

CHAPTER TWO: METHODOLOGY

Purpose

The purpose of the present study is to test the feasibility of implementing a video-game based intervention protocol as a means to improve therapy compliance in school age children with hyperfunctional voice disorders. Prior to disbursement of videogame software application, feasibility tests were conducted to analyze the programs performance and compatibility. The current study illustrates three levels of modification that were conducted to an existing entertainment software application for use as a therapeutic protocol.

The computer game, Opera Slinger was developed as a student project at the Florida Interactive Entertainment Academy and a binary source code was loaned to the investigators of the current study for use in a novel therapy protocol. Opera Slinger is an interactive game, which requires the participant to follow and compete against the lead character, Aria, through a set of vocal tasks (Appendix D). A participant plays the character Forte, an opera slinger who finds out that Aria (the lead character) has destroyed their opera house and wants to steal all the fans. In an effort to regain control, Forte competes with Aria in five spotlight competitions. The participant must maneuver their way around the opera house to find each of the five spot lights and then compete Aria in vocal resonator tasks (Appendix D). Points are cumulated for each spotlight and assessed for matching of pitch, duration and loudness. The most points at the end of the fifth spotlight will win the game.

Feasibility Tests

The first two levels of the feasibility study were conducted with two computer programmers (stability testing) and five normal adults (alpha testing) to analyze the programs

performance and function. Modifications were made after each feasibility level and are documented in the diff log located in Appendix E. The following tables 1 and 2 describe the results from the first two levels of feasibility testing:

Table 1: Level one modification

Level 1: Stability Testing
Performance testing was conducted by two experienced computer programs for analysis of software application and functionality with current operating system.
Stability testing: • Gamepad and keyboard functionality was impaired due to incompatibility with modified speed controls. • Faults were found in the time stamp directory when program was played in greater quantities. The storage file was moved from Operaslinger file to gamedata. • Spotlight scripts were noticeable impaired in spotlight three and four due to inversed quantities. Performance testing: • Internal audio devices were improperly obtaining the sound with external device, causing inadequate functioning with voice analysis. Headphones with input audio jacks were exchanged to USB 2.0.

Table 2: Level two modification

Level 2: Alpha Testing
Five adults (3 males and 2 females, between the ages of 23-27) with no vocal difficulty or diagnosis of a vocal pathology separately tested the software application and usability with computer, gamepad and headphones. Testing was performed with observation by an investigator.
Functional Changes: • Competitive behaviors increased the probability of poor vocal behaviors to occur when playing a video game. • All sustained phrases were revised and placed to a beat of a song. • Pauses between repetitions of exercises were lengthened and individual trials lengths were decreased. • The speed for the scrolling script for each spotlight exercise was reduced. • Point system needed to be expanded for each level to prevent hyperfunction. Structural Features: • Some participants struggled to get to each spotlight prior to the lead character. Therefore, parts of the exercise were missed. • A cheat button was added to help those participants who needed more time to get to the next stage Participant Suggestions: • Written directions with game • The stages should progress in difficulty to prevent frustration.

Modification to Opera Slinger for Therapeutic Needs

A resonant voice therapy protocol was devised using syllable repetitions, chanting of songs and phrases. Five voices (1 adult male, 1 female child, and 3 adult females) were analyzed for use as the guide during the spotlight exercises; an adult female was selected due to greater intelligibility and adequate resonant what do you mean by this quality within the game. Voice recordings were made of five exercises using the Computerized Speech Lab, Model 4500 from KayPentax in waveform at a sampling rate of 44.1 kHz and encoded with a bit resolution of 24. A unidirectional dynamic microphone was held five inches from the lips and 4 attempts at each

exercise were recorded. Each recording was visually analyzed for any pitch breaks or clipping, as well as appropriate length of time. One sound sample for each exercise was chosen. Audacity 1.2.6 which is a digital audio editor was used to trim, amplify, divide, and insert silence sections, as well as export sound files to the Ogg Vorbis format for use in the game. Each exercise was modified to fit into a specific timeframe for each spotlight. The syllable repetitions were multiplied three times and pause breaks were inserted. In addition, the sound samples were amplified by 12dB prior to conversion. The sound clips of each exercise were then attached to the current sound clips of the introduction and ending for each spotlight and inserted into the music file of the game.

Modifications were made to the point system which derives their values from the loudness, duration and pitch quantities in the spotlight notes. The point system has two separate levels accounting for male or female and three difficulty levels called novice, adept and virtuoso. The point breakdown for males and virtuoso were replaced with the quantitative values for female and adept, due to the similarities in fundamental frequencies values seen in research with male and female school age children (Bennett & Weinberg, 1979). The points allocated for high and low pitch were expanded to make it easier on the participant with a vocal pathology. Amplitude was lowered by two points to prevent the use of negative behaviors. The point system which derives the minimal or maximum values necessary for the pop-up boxes to be exposed was reduced in order to warn participants earlier about poor vocal behaviors. The rating scale was also modified to expand the data selection, however there were no noticeable signs in the game data that the change had occurred. The text data for each spotlight was modified using ++ Notepad v5.3.1 which is a program used for editing of source code. Each spotlight has three separate files for lyrics, notes, and information. The notes section lists the numerical values of

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each spotlight and is divide into high and low pitch, duration, and amplitude. These numerical values were modified to the acoustic markings of each spotlight therapy exercise. Exercises were quantitatively analyzed using the numerical values from the analysis of pitch and energy contours from Multi-Dimensional Voice Program Advanced (MDVP), Model 5105 (Kay Elemetrics, 1993). The values of duration were derived using the numerical values from the time domain analysis program on MDVP. All numerical values for amplitude were separated into levels from -5 to 5 with -5 being the lowest. Each spotlight file also has separate lyrics which scroll across the screen during the spotlight competition. This data was modified with the lyrics of the exercises and arranged according to the numerical values of duration of each pitch and length of spotlight session. Text data for each spotlight exercise can be seen in Appendix E.

Dialogue boxes and pop-up boxes were modified in accordance with the devised therapeutic procedure using GIMP 2.6 an image manipulation program. The dialogue boxes which give a written description of the spotlight activity were customized to each individual exercise. The pop-up boxes which appear during the spotlight exercise when a participant's voice is not appropriate were tailored to advise a greater resonant quality.

A standard gamepad script was generated by mapping the input data from the gamepad to the characters movement functions in the torque engine. A gamepad file existed in the source code, however all movements were linked to the computer mouse and keyboard. The script was written in C# and edited in Vi, an open source text editor. See Appendix E for exact modifications.

The timestamp directory was developed by modifying an existing logging function in the software program. The original program logged files of sound input each time the game was played and then immediately erased the file after the program restarted. To prevent the program

from erasing the files, a variable was created for the timestamp and output file in the gameManagers folder. Variables were also modified to save the time, date and song recorded, in order to properly manage compliance with the video game. The output is now saved as separate files that are not overwritten each time the player enters the game.

Video Game Application with Clinical Population

Hypotheses

This study aims to test the central hypothesis that therapy compliance can improve if the mode of voice therapy delivered is 'motivating' to the child. Specifically, the following hypotheses will be tested:

1. Ho: There will not be an increase in compliance for the participant during the time he receives the video game compared to the time he does not receive the video game by meeting or exceeding the home based voice therapy recommendations prescribed by the clinician\investigator.

   Ha: There will be an increase in compliance for the participant during the time he receives the video game compared to the time he does not receive the video game by meeting or exceeding the home based voice therapy recommendations prescribed by the clinician\investigator.

2. Ho: Therapy will not result in improvements in voice quality as observed in CAPE-V ratings from pre and post treatment.

    Ha: Therapy will result in improvements in voice quality as observed from CAPE-V ratings pre and post treatment.

3. Ho: Therapy will not result in improvements of patient's perception of their voice handicap as observed by ratings made on the pediatric Voice Handicap Index from

pre and post treatment.

Ha: Therapy will result in improvements in patient's perception of vocal handicap as observed by ratings made on the pediatric Voice Handicap Index from pre and post treatment.

4. Ho: Therapy will not result in improvements in voice quality as measured from acoustic data from pre and post treatment.

Ha: Therapy will result in improvements in voice quality as measured from acoustic data from pre and post treatment.

Study Design

The case study represents a two-phase quasi-experimental design with the participant receiving the video game therapy protocol and traditional therapy for equal time. The participant received pre- post- measures in order to analyze the changes in compliance and vocal quality when using the video game. The baseline measures included perceptual and acoustic assessments of voice quality and laryngeal function. The independent variables for this study include the mode of voice therapy delivery (traditional vs. video game). The dependent variable includes therapy compliance, vocal quality, and acoustic measures.

General Methods

Participant

The participant is a 9 year old male who was recruited from the Seminole County Public Schools Annual Voice Evaluation Program and The Ear, Nose & Throat Surgical Associates. An in depth diagnostic history and laryngeal imaging with videolarygostroboscopy of the participant was conducted by an otolaryngologist and speech pathologist to observe the structure and function of the vocal folds. An otolaryngologist diagnosed the participant as having a

hyperfunctional voice resulting from bilateral vocal fold nodules. The participant was recommended for voice therapy as their primary treatment. Prior to admittance in this study the participant and parent signed an informed consent.

Experimental Measures

<u>Compliance</u>

During the traditional and non-traditional therapy practices the participant was asked to keep account of all exercises practiced with a weekly scheduler. The participant and/or parent were instructed to keep track of the date, time and amount of exercises preformed each day. Forms were turned in each week to the investigators for documentation. During the non-traditional therapy protocol the video game also collected compliance data, however neither the participant or parent was informed. A collection of acoustic samples were taken during each spotlight exercise accessed by the participant while playing the game. Each time the participant maneuvered his character into the spotlight and performed an exercise a new acoustic data file was created with a UNIX time stamp in the directory. The loudness, pitch and duration were measured and stored in each file, however due to the poor sampling rate and encoding the acoustic data could not be used for further analysis. Consequently, the time stamp provided by each file was used to measure the participant's compliance levels with each exercise, as well as the participant's own account. The time stamp was converted to a standard date and time when opened through the Windows XP user interface command prompt. The text file was then exported into EXCEL for further analysis. Compliance was measured through completion of the game and the amount of usage in one day and during a one-week interval.

<u>Baseline Measures</u>

Two baseline measures were obtained from the participant prior to the start of therapy and after the conclusion of therapy. The baseline measures included perceptual and acoustic assessments of voice quality and laryngeal function. An audio sample was collected and recorded, during which the participant was asked to perform vocal tasks which included: sustaining the vowel /a/, pitch glides, and reading of the rainbow passage (Fairbanks, 1940). An Edirol R-09 linear Pulse-code modulation (PCM) recorder was used to collect the speech sample from the participant. Mouth to microphone distance was held constant for both measures at 15 inches from the internal stereo condenser microphone to the lips. The recorder was placed directly in front of the participant at a 45 degree angle on a table. The audio recording was captured in waveform format with a sample rate of 48.1 kHz and encoded with a bit resolution of 24. The sample was then trimmed with Audacity a digital audio editor. The sustained /a/ and connected speech sample of the third sentence in the rainbow passage was analyzed using the Multi-Dimensional Voice Program Advanced, Model 5105 (Kay Elemetrics, 1993).

Perceptual

The Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V, Appendix A) was used to evaluate the quality of the participant's voice. The CAPE-V is an assessment tool, which measures the severity of auditory-perceptual characteristics of the voice through a rating scale, which may be applicable to a broad range of vocal pathologies (Kempster, Gerrat, Verdolini Abbott, Barkmeier-Kraemer, & Hillman, 2008). A voice sample for the CAPE-V was gathered by having the participant sustain vowels /a/ and /i/, read 6 standard sentences that elicit various laryngeal behaviors and clinical signs, and answer interview questions, in order to obtain a 20 second natural conversational speech sample.

Two experienced SLP's with 10 plus years in evaluating and treating voice disorders analyzed the audio recording of the participant's voice sample using the CAPE-V instrumental tool, measuring the following characteristics: overall severity, roughness, breathiness, strain, pitch, & loudness. The clinician measured each attribute using a 100 millimeter line which forms a visual analogue scale (VAS), by marking the degree of perceived deviances with a dash. References indicating severity levels of deviances are listed under each line with the statements of mild, moderate and severe. The clinicians indicated if the particular voice attribute was represented consistently, by being present throughout the task or intermittently, by occurring inconsistently. The results of the CAPE-V from two evaluators were averaged.

The Pediatric Voice Handicap Index (pVHI, Appendix B) was given to the participant's mother in order to assess his perception of voice using emotional, functional and physical subscales (Zur, Cotton, Kelchner, Baker, Weinrich, & Lee, 2007). This index is a modification of the commonly used Voice Handicap Index (VHI) for the adults. The pVHI is a 23-item assessment and has no normative values relating to the scores (Zur, Cotton, Kelchner, Baker, Weinrich, & Lee, 2007). Two of the questions specifically asked the parent to rate the child's voice using a 100 millimeter line which forms a visual analogue scale (VAS), by marking the degree of perceived deviances with a dash. The remaining 21 questions asked the parent to rate their child's impacts from their voice disorder on their daily activities with a nominal scale of 0 being never to 5 being always.

A revised pediatric Voice Handicap Index (pVHI, Appendix C) was given to the participant to evaluate their own perception of voice severity and rate its impact on daily activities. This revision of the pVHI is a by-product of the original pVHI and modifications included reformatting written questions into first person and age appropriate rhetoric. This

assessed the participant's opinion of their function, emotional and physical voice handicaps. Further analysis can be drawn from the results about the participant's personal perceptual rating abilities.

Acoustic

The acoustic measures that were assessed include mean fundamental frequency, intensity, fundamental frequency tremor, jitter percent, shimmer percent, and noise to harmonic ratio (NHR) (Niedzielska, 2001). Fundamental frequency measured the rate of vibration of the vocal folds and was measured in Hertz (Hz) and reflected the cycles of vocal fold oscillation. Vocal intensity measured the amount of power per unit area, which reflected loudness levels and was measured in decibels (dB). Fundamental frequency tremor measures the rate of periodic change of frequency and is measured in Hertz (Hz). The jitter percent provided the percent of cycle to cycle irregularity of the pitch. The shimmer provided the percent of cycle to cycle irregularity of the peak to peak amplitude of the voice. The noise to harmonic ratio measured the degree of aperiodic noise versus harmonic energy by comparing signal strength with energy of noise. The participant was asked to produce 3 sustained vowels in a comfortable pitch and loudness, and read the entire Rainbow passage. The second recorded sustained sound and the third sentence in the rainbow passage was used for analysis. The voice samples were acoustically analyzed using the Kaypentax software, Multi-Dimensional Voice Program Advanced (Kay Elemetrics, 1993).

Procedure

An independent SLP provided weekly one hour treatment sessions to the participant for four weeks. The participant was directed through an eclectic voice therapy approach of Resonance Voice and vocal hygiene therapy. The initial session included educating the client about the anatomy and physiology of voice production, as well as training techniques that will

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help to facilitate better vocal performance. The participant was taught increased resonate behaviors similar to Lessac-Madsen Resonant Voice Therapy (LMRVT). The initial stage of these exercises involved humming the consonant /m/, chanting nonlinguistic phrases and linguistic phrases, and over inflection of phrases in speech (Verdolini-Abbott, 2008). The stages of the exercises progressed in complexity in accordance with the participant to voice-voiceless contrasts, any phrase, controlled conversations, and environmental manipulations. This approach enhanced the participant's sensory awareness of their voice and provided healthier behavioral practices. Similar procedures were prescribed for home based therapy practice two times per day for five days a week. The modal was presented in traditional therapy and non-traditional therapy or video game based format. The instructions consisted of one trail of each exercise or one complete cycle of the video game, two times a day for 5 days a week. Weekly evaluations were assessed by the participant's SLP to determine advancement into the later stages of the therapy protocol.

The participant was assigned the game during the second phase of therapy and was given verbal and written directions on the use of the gaming device and take home protocol. The participant was provided an Apple Macbook pro laptop computer, Logitech Dual Action gamepad, and Logitech USB headphone set with attached microphone. The video game, Opera Slinger was uploaded and accessible on the user desktop for a shortcut access to the game. No other computer applications were accessible. Opera Slinger 1.0 was originally designed to combine karaoke within the elements of a classic action platform, by detecting a participant's pitch. It is an interactive game, which requires the participant to follow and compete the lead character, Aria, through a set of vocal tasks. The framework of the game was designed with realistic speaking characters and graphics, within a fast moving, competitive environment. The

software program has been modified from the original and was released to the participant as a prototype. A scripted dialogue of Resonant Voice Therapy was adapted in the game with specific revisions made to spotlight songs and pop-up boxes, as well as dialogue boxes. Further modifications were made to the accessibility and use of the game for therapeutic needs. The application had passed alpha testing stage with normal participants prior to release. Therapeutic exercises were monitored and adapted as the client progressed through their goals. The therapy protocol took place for four weeks, with the participant receiving two weeks of traditional therapy and two weeks of video game based therapy. Due to multiple scheduling conflicts the patient was seen between a seven week time span, however data was only used during the weeks of prescribed therapy.

Post-treatment data collection was obtained at the end of week 4 in order to collect acoustic and perceptual measures, laryngeal imaging with videolaryngostroboscopy was completed, and reestablishment of therapy exercises and medical management.

CHAPTER THREE: RESULTS

<u>Descriptive Statistics</u>

This case study represents a two-phase quasi-experimental design with the participant receiving the video game therapy protocol and traditional therapy for equal amounts of time. The independent variable for this study was the mode of voice therapy delivery (traditional vs. video game). The dependent variables were compliance, Pediatric Voice Handicap Index (pVHI), Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V) and acoustic analysis of sustained pitch and connected speech. Descriptive statistics included mean and standard deviations for all dependent variables.

<u>Compliance</u>

Tables 3, 4, 5 and 6 depict the compliance levels for all four weeks of therapy. Compliance levels for Traditional therapy versus Non-Traditional therapy are substantially different; results show that the participant used the video game 4 times compared to 16 attempts with traditional therapy. During week 3 and 4 the participant combined traditional therapy with the non-traditional therapy, which showed a greater amount of compliance measured by practicing two times per day. Table 4 shows the weekly timetable for the participant and indicates an increase in missed appointments and decrease in average amount of practice days during the two weeks of traditional therapy. The table also indicates that the participant had a 100% average compliance with practicing two exercises for 5 days a week during the first week of Non-traditional therapy and 80% average compliance on the second week. Table 4 verifies that the patient practiced his exercises more on Tuesday and Wednesdays for both traditional and non-traditional protocols, however there were no notable findings that one day of the week was

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better than another. Tables 5 and 6 showed that the participant began his therapy practice for

weeks 3 and 4 immediately after the therapy session and maintained twice a day practice for 7

straight therapy practice dates, compared to 4 days in weeks 1 and 2.

Table 3: Amount of compliance achieved each week with Traditional and Non-Traditional
Therapies

Therapy	wk #1	wk #2	wk #3	wk #4	Compliance
Traditional	8	8	7	7	16
Non-Traditional	n/a	n/a	1	3	4

Table 4: Weekly timetable of events and averages of therapy practice and attendance at therapy session

Schedule	Dates	# Days	Therapy Average with 1 practice	Therapy Avg with 2 prac.	Mon.	Tues.	Wed.	Thurs.	Fri.	S/S
Week # 1	4/16/09 to 4/23/09	8	80%	80%	1	1	1	1	0	1
Missed	4/24/09 to 4/29/09	6								
Week # 2	4/30/09 to 5/7/09	8	100%	60%	1	1	1	0	1	1
Missed	5/8/09 to 5/19/09	11								
Week #3	5/20/09 to 5/27/09	8	100%	100%	0	1	2***	1	0	1
Week #4	5/27/09 to 6/2/09	7	100%	80%	1	1*	1	1	1	0
Total	4/16/09 to 6/2/09	48	95%	80%	3	4	5	3	2	3

*denotes the days the participant used the non-traditional method for therapy

Table 5: Compliance schedule for week 1 and 2 of Traditional therapy

Date	#1	#2	All/day
4/16/2009	1st day of therapy		
4/18/2009	10:00am	4:00pm	1
4/20/2009	7:15am	6:00pm	1
4/21/2009	7:30am	6:45pm	1
4/22/2009	8:00am	6:45pm	1
5/1/2009	n/a	4:30pm	0
5/3/2009	2:00pm	7:00pm	1
5/4/2009	7:30am	5:15pm	1
5/5/2009	8:00am	6:30pm	1
5/6/2009	n/a	4:20pm	0
Total	**8**	**8**	7

Table 6: Compliance schedule for week 3 and 4 of Traditional and Non-Traditional therapy

Compliances with Wk 3 & 4			
Date	**#1**	**#2**	All/day
5/20/2009	1st day	7:30pm	1
5/21/2009	8:05am	6:00pm	1
5/23/2009	11:00am	8:00pm	1
5/26/2009	7:30am	5:00pm	1
5/27/2009	8:00am	7:30pm	1
5/28/2009	7:30am	6:30pm	1
5/29/2009	7:30am	7:00pm	1
6/1/2009	n/a	5:30pm	0
6/2/2009	8:00am	7:00pm	1
6/3/2009	7:30am	last day	1
Total	**8**	**9**	**9**

*grayed areas show the day's non-traditional therapy was used

Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V)

Table 7 depicts the mean and standard deviation of two Speech Language Pathologists rating the participant's voice quality pre and post baseline. The results show differences amongst raters' scores within each baseline. However, there is a noticeable change between the participants pre and post baseline. Individual factors with the most change between pre and post were overall severity, breathiness and strain. One of the raters also noted in the additional features section intermittent aphonia at the end of phrases during pre-baseline and none noted during post-baseline.

Table 7: The results of the participant's pre and post perceptual evaluation using the CAPE-V

Evaluation	SLP	Pre-Baseline	Mean	SD	Post-Baseline	Mean	SD
Overall Severity	#1	65	80.0	21.2	43	59.0	22.6
	#2	95			75		
Roughness	#1	13	24.0	15.5	7	16.0	12.7
	#2	35			25		
Breathiness	#1	58	78.0	28.2	26	46.5	28.9
	#2	98			67		
Strain	#1	33	65.5	45.9	5	27.5	31.8
	#2	98			50		
Pitch	#1	13	6.5	9.1	0	0	0.00
	#2	0			0		
Loudness	#1	8	4.0	5.6	0	0	0.00
	#2	0			0		
Additional Features: #1:		Pre: intermittent aphonia at the end of phrases			Post: No noted aphonia		

Pediatric Voice Handicap Index

Table 8 and 9 illustrate the mean and standard deviations of the results for the Pediatric Voice Handicap Index and subtests across pre and post baselines. The participant and parent filled out the index in regards to the participant's talkativeness, impact of his voice disorder on

his daily activates, and severity ratings of his voice. The participant and parent were found to have similar responses to the participant's level of talkativeness and overall severity. Mean and Standard deviation were greatest with total subtest scores for both pre and post baseline. There were also differences between individual subtests with the parent scoring reasonable higher than the participant on both pre and post measures.

Table 8: Pediatric Voice Handicap Index pre-baseline measurement

pVHI Pre- Baseline	Parent	Participant	Mean	SD
Level of Talkativeness	5	4	4.5	0.7
Total Subtests	48	11	29.5	26.1
Functional	14	2	8	8.4
Physical	21	8	14.5	9.1
Emotional	13	1	7	8.4
Severity Rating	68	65	66.5	2.1

Table 9: Pediatric Voice Handicap Index post-baseline measurement

pVHI Post- Baseline	Parent	Participant	Mean	SD
Level of Talkativeness	5	4	4.5	0.7
Total Subtests	42	14	28.0	19.8
Functional	11	2	6.5	6.3
Physical	25	10	17.5	10.6
Emotional	6	2	4.0	2.8
Severity Rating	80	75	77.5	3.5

Vocal Quality

Table 10, 11 and 12 represent the mean and standard deviations for the acoustic variables analyzed with the participant's sustained pitch and connected speech, pre and post baseline. The data showed minimal variability between the first, second or third sustained pitch measurements. There were moderate differences between the participant's jitter percent which might infer differences in cyclical variations of the patient's fundamental frequency. There were also substantial differences in the participant's fundamental frequency tremor and shimmer percent. The patient's pre and post acoustic measures for connected speech sample had moderate differences between standard deviations of their fundamental frequencies.

Table 10: Participant's pre-baseline sustained pitch

Pre Measures	1st	2nd	3rd	Mean	SD
Mean Fo(Hz)	248.20	248.45	250.20	248.95	1.09
Jitt %	2.61	3.25	1.85	2.57	0.70
Fo Tremor	8.89	9.76	5.97	8.21	1.98
Shim %	4.21	5.09	5.68	4.99	0.74
NHR	0.12	0.13	0.15	0.13	0.02
Mean Amp (dB)	61.34	59.26	60.53	60.38	1.05

Table 11: Participant's post-baseline sustained pitch

Post Measures	1st	2nd	3rd	Mean	SD
Mean Fo(Hz)	241.59	233.57	237.45	237.54	4.01
Jitt %	0.58	1.23	1.17	0.99	0.36
Fo Tremor	3.05	2.29	2.48	2.61	0.40
Shim %	6.02	9.07	7.89	7.66	1.53
NHR	0.14	0.17	0.16	0.15	0.02
Mean Amp (dB)	66.58	65.93	66.57	66.36	0.37

Table 12: Acoustic measures pre- and post- treatment for connected speech

Connected Speech	Pre	Post
Mean Fund. Freq (Hz)	264.55	253.27
SD of Fo	16.51	19.07
Mean Amp (dB)	58.41	61.14

Inferential Statistics

A paired sample t-test was used to compare therapy compliance in traditional versus non-traditional, as well as differences between pre and post baseline scores for the CAPE-V and the acoustic analysis of amplitude dependent variables. The data was analyzed using Microsoft Office Excel 2007 (Excel, 2007).

Compliance

Compliance to traditional therapy versus non-traditional therapy was measured according to the amount of practice exercises the participant performed at home each week. Results showed a significant increase for traditional therapy exercises performed each week ($t=2.91$; $p<0.02$), however a greater number of total exercises were practiced during weeks three and four.

Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V)

The CAPE-V is a perceptual assessment of the participant's vocal quality judged by Speech Language Pathologists experienced in the field of voice disorders. The assessment reviews several parameters specific indicators of vocal pathologies, the attributes are overall severity, roughness, breathiness, strain, pitch, and loudness. A paired two sample mean t-test was conducted using the values from strain, breathiness and overall severity from the CAPE-V and results demonstrated a statistical significance between the pre and post measures ($t= 1.81$; $p < .03$).

Vocal Quality

Vocal intensity measured the amount of power per unit area, which reflected the loudness levels of the participant and was measured in decibels (dB). The results concluded a statistically significant difference in amplitude levels post therapy ($t = 2.91$; $p > 0.002$).

CHAPTER FOUR: DISCUSSION

The purpose of the present study is to test the feasibility of implementing a video-game based intervention protocol as a means to improve therapy compliance in school age children with hyperfunctional voice disorders. This study aimed to illustrate three levels of modification that were conducted to an existing entertainment software application for use as a therapeutic protocol. Furthermore, test the central premise that therapy compliance can improve if the mode of voice therapy delivered is 'motivating' to the child.

The success of voice therapy for a school age child relies heavily on the motivation of the patient to continue the use of therapeutic exercises at home (Deal, McClain, Sudderth, 1976; Glaze, 1996). Judgments of a patient's improvement with therapy can be evaluated through compliance of exercises, perceptual results from patient and Speech Language Pathologist, as well as analysis of vocal quality.

Compliance

Compliance was measured by comparing two weeks of traditional voice therapy with two weeks of non-traditional voice therapy. Although it was originally hypothesized that there would be greater compliance with non-traditional voice therapy, the data from the current study demonstrated substantial increases in the total amount of traditional therapy exercises completed during the assigned two weeks of therapy. The participant practiced a greater number of total exercises during the two weeks of non-traditional therapy protocol, however the use of the video game during that time period was not found to be significantly different. Minor differences were also noticeable in participant's compliance schedules during the weeks of non-traditional therapy protocol, such as: beginning exercises immediately after therapy session and greater consistency

with practicing twice a day. Based on the compliance data from all four weeks there were no substantial changes in compliance and the patient showed an 80% average consistency with practicing exercises throughout the duration of the study.

The results for compliance in the current study do not follow trends observed in the literature for school age children. Possible explanations for the differences observed with the current participant are limited in ways of tracking traditional therapy, parent support, and study design. Each time the participant used the video game a script was written to the source code of the computer, this allowed for accurate documentation. However, during the traditional therapy protocol the patient was asked to document all of their own accounts, which may have been inaccurate. Another problem that occurred during the study was that the participant's parents lived in separate homes and to prevent any breakage of the computer, the computer remained at the main caretaker's home. Another factor that may have affected the compliance levels was that the study was designed for four weeks, 2 weeks of traditional therapy and then two weeks of non-traditional therapy. This did not appear to be an adequate amount of time to measure change in compliance with a video game.

Therefore, results of compliance with non-traditional therapy protocols fail to reject the null hypothesis and conclude that there is not enough evidence to state that the alternative is true. Further investigation with a large sample size will be necessary to fully understand if a video game therapy protocol can improve school age children's compliance with voice therapy.

<u>Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V)</u>

Perceptual evaluations were assessed by two Speech Language Pathologists to rate the participants roughness, breathiness, strain, pitch, loudness and overall severity of their voice. Previous researchers have found that severity of perceptual voice analysis's can be correlated

with the presentation of a voice pathology and therefore be an accurate means of objective evaluation (Shah, Woodnorth, Glyn, & Nuss, 2005). The results concluded noticeable differences between inter-rater reliability due to the degree of differences between each of the rater's scores pre and post baseline, however each rater illustrated significant changes in the patient's breathiness, strain and overall severity of voice. In future studies, the listening environment and equipment will need to be control for. Based on the analysis of the data differences in perceptual evaluations pre and post baseline are statistically significant, therefore the null hypothesis is rejected and therapy will result in more improvements in voice quality as observed on the CAPE-V.

<div align="center">Pediatric Voice Handicap Index</div>

Participant and parent perceptual assessment of the effects of vocal quality on daily activities and overall severity ratings were made. The original pVHI was devised for the parent to fill out and rate according to functional; physical, and emotional effects of their child's voice; and modifications were made to the document so that the participant would be able to make ratings regarding their perceived vocal handicap. The results suggest that there were noticeable differences between the parent and participant's perceived scores on each subtest, however during the severity and talkativeness ratings both scores were analogous. No change was noticeable in either the pre or post baseline scores of the parent or participant with regard to the quality of the participant's voice being unpredictable or the sound of their voice changing throughout the day. Participant and parent reported changes pre to post baseline indicating the participant's voice difficulty was less severe in the evening. Both the parent and participant reported at the post baseline assessment that there were increases in the participant's voice sounding dry, raspy, and hoarse. Pre and post subtest scores from the parent also indicated a

minimal difference on the overall effect the voice difficulty had on performing daily activities, conversely the parent rated the participant's overall severity as worse in post baseline than at the time of the pre- baseline data collection. The participant rated himself substantially less in the functional and emotional subtests. One possible explanation for this was difficulty in understanding or comprehending what the question was asking for.

In addition, there were no statistically significant differences between the pre and post baseline scores on the individual subtests. Normative data using this index is currently not available given the degree of severity of the participant's vocal pathology, therefore it was not used for analysis.

<u>Vocal Quality</u>

Acoustic analysis can give objective measures to help indicate the possibility of a vocal pathology and quantitatively rate progress in therapy (Niedzielska, 2001). The participant's vocal quality was subjected to acoustic analysis pre and post baseline from a sustained pitch and connected speech samples. Some of the most noticeable changes observed between normal voices and children with structural vocal pathology's are fundamental frequency tremor and noise to harmonics ratio, which seem to characterize the perception of strain in a child's voice (Niedzielska, 2001). The results of the participant's fundamental frequency tremor lowered substantially from pre baseline to post baseline. Current data for fundamental frequency tremor places the participant's pre- baseline score three deviations above the normative values (2.86%, sd 2.29), however his post baseline scores were documented within one standard deviation (Niedzielska, 2001). There were no noticeable differences in pre and post baseline of the participant's noise to harmonic ratio. Results of the participant's pre and post baseline mean fundamental frequency and amplitude for sustained pitch were within one standard deviation of

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the mean of a normal 7 to 10 year old boy (219 Hz, sd 44.9; 61.5 dB, sd 5; Baken & Orlikoff, 2000; Bohme & Stuchlik, 1995). There were no substantial differences between his pre and post baseline fundamental frequencies, however results showed statistical significances in his amplitude during sustained pitch. In addition, the participant's results for shimmer were substantially greater during post baseline and compared to normative values (4.07%, sd 1.78; Nicollas, Garrel, Oaknine, Giovanni, Nazarian, & Triglia, 2008). The participant's results of jitter percent were substantially greater pre baseline than post baseline, however they still were moderately greater than normative values (.43%, sd .24; Nicollas, Garrel, Oaknine, Giovanni, Nazarian, & Triglia, 2008).

Pre-baseline laryngostroboscopic findings revealed the appearance of bilateral vocal fold nodules. Laryngostroboscopic results post-baseline indicated a cyst formation on the left true vocal fold with a reduction of generalized edema surrounding the cysts formation; the right true vocal fold nodular prominence had resolved. These findings, although not part of the experimental design of the current study, suggest that therapy progress was made based on the level of severity of laryngeal findings, little to no change in the acoustic results were to be expected, as it is widely agreed upon in the literature that vocal fold cyst's rarely respond to behavioral therapy alone, and more typically require combined modality management with surgical excision (Stemple, Glaze, & Klaben, 2000).

<center>Limitations</center>

This study aimed to test the feasibility of using a video game as a therapy device to improve the motivation of school age children to practice home based exercises. Although this study failed to prove that the video game could improve motivation towards therapy, it was established that a purely entertainment game can be modified for therapeutic purposes and be

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implemented into future voice therapy protocols. The statistical results of the study would have

benefited from a greater number of participants and lengthier time period with the video game.

However, due to the novelty of the video game approach for therapy it was of value to have had

the opportunity to run a single subject design. The experience with the participant and the

limitations uncovered in the data analysis has shed light on further modification that will help to

improve the application and functionality of the game. For example, the participant reported that

the game was a little hard and that he found it to be tiring by the time he got to the last exercise;

therefore, modifications were made to make the game easier at the beginning and progressively

get harder. Another limitation was the study design, which allocated traditional therapy and non-

traditional therapy in a case study. This unfortunately limited the abilities to interpret precisely

how much the game influenced the participant's motivation. Perhaps another way to study this

use of the video game is to design a protocol including a control group with only mild vocal fold

pathology. Another limitation within the study was that data for the traditional portion of this

study relied solely on the participant's ability to accurately keep track of their exercises. This

factor alone might have lead to the greater variability in the results observed because the

participant's data was compared to quantitative data collected by the source code. In future

studies, a better ability of collecting compliance data should be devised; possibly by having the

participant use a sound recorder during the traditional therapy protocol or have the participant

rate when they performed the game versus when they did not.

<u>Future Studies</u>

Current results will facilitate greater modifications to the video game for increased

functionality and application as a therapeutic practice. Although it was not controlled for in the

study, anecdotal clinical comments from the participant and parent in the post treatment baseline

indicated high motivation to complete the video game exercises. The parent stated that she had to do less prompting and reminding about the exercises and he would begin them without direction. The participant also reported that he found the graphics and competitiveness to be appealing.

Future studies should include a greater number of participants over a longer period of time (i.e. use of videogame for a minimum of 3 weeks), Also, future studies should implement strict procedures for the therapeutic sessions which can work in conjunction with the computer game to provide adequate feedback. Therapy sessions should include a review the participant's ability to perform the therapy tasks with the video game and modify the game as needed.   .

The design of the study should also be revised from a two-phase quasi-experimental design to a multiple time-series design. This design accounts for multiple measures over time with an experimental group and control group. Results can help compare the differences in compliance and vocal quality with traditional and non-traditional therapy protocols. Selection of participants should only include those with a mild vocal pathology, due to their greater susceptibility to improvement with therapy.

Future research beyond the scope of this study should include increased designs of video game options and greater speech analysis systems. The video game therapy approach can be a catalyst for studying vocal quality during at home practice sessions and find new innovated ways of improving quality of speech and voice characteristics.

<u>Summary</u>

Clinicians use a variety of therapy approaches to reduce vocal hyperfunction and compensatory vocal behaviors for hyperfunctional voice disorders in children. The development of the therapy model in a serious gaming environment can provide multiple benefits to a school age child with a vocal pathology. This pilot study illustrated three levels of modification that

were conducted to an existing entertainment software application for use as a therapeutic protocol. Prior to disbursement of the modified software application, feasibility tests were conducted to analyze the programs performance and compatibility to the attended population. The following modifications were made to the video game for use as a therapeutic protocol. Resonant Voice therapy protocols were devised and replaced the five original spotlight songs (syllable repetitions, chanting a song, and phrases). Dialogue boxes, pop-up boxes, and script which runs during the spotlight were also modified in accordance with the therapeutic procedure. In addition, a time stamp directory was added which saves the pitch and loudness level of each participant during each individual exercise, as well as documents the compliance level of each exercise. A standard gamepad script was generated for a dual joystick gamepad to add to keypad and mouse control and make the video game more functional.

The purpose of the third stage of modification was to test the feasibility of implementing the video-game based therapy as a means to improve therapy compliance in school age children with hyperfunctional voice disorders. This study found that a purely entertainment video game can be implemented as a therapeutic protocol for a school age child diagnosed with a vocal pathology. Even though, the results for compliance in this study were greater for traditional therapy, improvements in design and function of the video game have been extremely successful. Therefore, further investments should be made to implement this video game based therapy with multiple participants and advance the research in studying therapy compliance

APPENDIX A: CONSENSUS AUDITORY PERCEPTUAL EVALUATION

OF VOICE (CAPE-V)

Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V)

Name:_____   Date:_____

The following parameters of voice quality will be rated upon completion of the following tasks:
1. Sustained vowels, /a/ and /i/ for 3-5 seconds duration each.
2. Sentence production:
    a.   The blue spot is on the key again.   d.   We eat eggs every Easter.
    b.   How hard did he hit him?   e.   My mama makes lemon muffins.
    c.   We were away a year ago.   f.   Peter will keep at the peak.
3. Spontaneous speech in response to: "Tell me about your voice problem." or "Tell me how your voice is functioning."

> **Legend:** C = Consistent   I = Intermittent
> MI = Mildly Deviant
> MO =Moderately Deviant
> SE = Severely Deviant

SCORE

Overall Severity _____   C   I   ____/100
                 MI   MO   SE

Roughness _____   C   I   ____/100
                 MI   MO   SE

Breathiness _____   C   I   ____/100
                 MI   MO   SE

Strain _____   C   I   ____/100
                 MI   MO   SE

Pitch   (Indicate the nature of the abnormality): _____
_____   C   I   ____/100
                 MI   MO   SE

Loudness   (Indicate the nature of the abnormality): _____
_____   C   I   ____/100
                 MI   MO   SE

_____ _____   C   I   ____/100
                 MI   MO   SE

_____ _____   C   I   ____/100
                 MI   MO   SE

COMMENTS ABOUT RESONANCE: NORMAL   OTHER (Provide description):_____
_____

ADDITIONAL FEATURES (for example, diplophonia, fry, falsetto, asthenia, aphonia, pitch instability, tremor, wet/gurgly, or other relevant terms):

Clinician:_____

APPENDIX B: PEDIATRIC VOICE HANDICAP INDEX (pVHI)

Pediatric Voice Handicap Index

I would rate my child's talkativeness as the following (circle response)

1	2	3	4	5	6	7
Quiet			Average			Extremely
Listener			Talker			Talkative

Instructions: These are statements that many people have used to describe their voices and the effects of their voices. Circle the response that indicates how frequently you have the same experiences.

0= Never   1= Almost Never   2= Sometimes   3= Almost always   4= Always

Part I: F

1) My child's Voice makes it difficult for people to hear him.   0 1 2 3 4
2) People have difficulty understanding my child in a noisy room.   0 1 2 3 4
3) At home, we have difficulty hearing my child when he/she calls
   through the house.   0 1 2 3 4
4) My child tends to avoid talking because of his voice.   0 1 2 3 4
5) My child speaks with friends, neighbors, or relatives less
   often because of his voice.   0 1 2 3 4
6) People ask my child to repeat him when speaking face-to-face.   0 1 2 3 4
7) My child's voice difficulties restrict personal, educational and
   social activities.   0 1 2 3 4

Part II: P

1) My child runs out of air when talking.   0 1 2 3 4
2) The sound of my child's voice changes throughout the day.   0 1 2 3 4
3) People ask, "What's wrong with your child's voice?"   0 1 2 3 4
4) My child's voice sounds dry, raspy, and/or hoarse.   0 1 2 3 4
5) The quality of my child's voice is unpredictable.   0 1 2 3 4
6) My child uses a great deal of effort to speak (e.g., straining)   0 1 2 3 4
7) My child's voice is worst in the evening.   0 1 2 3 4
8) My child's voice "gives out" when speaking.   0 1 2 3 4
9) My child has to yell in order for others to hear him.   0 1 2 3 4

Part III: E

1) My child appears tense when talking to others because of his voice.   0 1 2 3 4
2) People seem irritated with my child's voice.   0 1 2 3 4
3) I find that other people don't understand my child's voice problem.   0 1 2 3 4
4) My child is frustrated with his voice problem.   0 1 2 3 4
5) My child is less outgoing because of his voice problem.   0 1 2 3 4
6) My child is annoyed when people ask him to repeat myself.   0 1 2 3 4
7) My child is embarrassed when people ask him to repeat myself.   0 1 2 3 4

Overall Severity Rating of Voice (Please place "X" mark anywhere along this line to indicate the severity of your child's voice; the verbal description serve as a guide)

_____

Normal   Severe

APPENDIX C: PEDIATRIC VOICE HANDICAP INDEX (REVISED)

Pediatric Voice Handicap Index (revised)

I would rate my talkativeness as the following (circle response)

1	2	3	4	5	6	7
Quiet			Average			Extremely
Listener			Talker			Talkative

Instructions: These are statements that many people have used to describe their voices and the effects of their voices

  0= Never   1= Almost Never   2= Sometimes   3= Almost always   4= Always

Part I: F

1. People have trouble hearing me.	0 1 2 3 4
2. People have difficulty understanding me in a noisy room.	0 1 2 3 4
3. At home, my parents have difficulty hearing me when I call through the house.	0 1 2 3 4
4. I tend to avoid talking because of my voice.	0 1 2 3 4
5. I speak with friends, neighbors, or relatives less often because of my voice.	0 1 2 3 4
6. People ask me to repeat myself when speaking face-to-face.	0 1 2 3 4
7. My voice difficulties restrict personal, educational and social activities.	0 1 2 3 4

Part II: P

1. I run out of air when talking.	0 1 2 3 4
2. The sound of my voice changes throughout the day.	0 1 2 3 4
3. People ask, "What's wrong with your voice?"	0 1 2 3 4
4. My voice sounds dry, raspy, and/or hoarse.	0 1 2 3 4
5. The quality of my voice is unpredictable.	0 1 2 3 4
6. I use a great deal of effort to speak (e.g., straining).	0 1 2 3 4
7. My voice is worst in the evening.	0 1 2 3 4
8. My voice "gives out" when speaking.	0 1 2 3 4
9. I have to yell in order for others to hear me.	0 1 2 3 4

Part III: E

1. I am tense when talking to others because of my voice.	0 1 2 3 4
2. People seem irritated with my voice.	0 1 2 3 4
3. I find that other people don't understand my voice problem.	0 1 2 3 4
4. I am frustrated with my voice problem.	0 1 2 3 4
5. I am less outgoing because of my voice problem.	0 1 2 3 4
6. I am annoyed when people ask me to repeat myself.	0 1 2 3 4
7. I am embarrassed when people ask me to repeat myself.	0 1 2 3 4

Overall Severity Rating of Voice (Please place "X" mark anywhere along this line to indicate the severity of your voice; the verbal description serve as a guide)

Normal   Severe

APPENDIX D: OPERA SLINGER

APPENDIX E: MODIFICATIONS TO OPERA SLINGER

```
----------MAIN MENU LOADING-------------
Index: common/client/prefs.cs
===================================================================
--- common/client/prefs.cs      (.../operaslinger)     (revision 1)
+++ common/client/prefs.cs
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)
@@ -114,7 +114,7 @@
 $pref::Video::allowOpenGL = "1";
 $pref::Video::appliedPref = "1";
 $pref::Video::clipHigh = "0";
-$pref::Video::defaultsRenderer = "GeForce Go 7800 GTX/PCI/SSE2";
+$pref::Video::defaultsRenderer = "GeForce 9600M GT/PCI/SSE2";
 $pref::Video::defaultsVendor = "NVIDIA Corporation";
 $pref::Video::deleteContext = "1";
 $pref::Video::disableVerticalSync = 1;
@@ -123,7 +123,7 @@
 $pref::Video::monitorNum = 0;
 $pref::Video::only16 = "0";
 $pref::Video::preferOpenGL = "1";
-$pref::Video::profiledRenderer = "GeForce Go 7800 GTX/PCI/SSE2";
+$pref::Video::profiledRenderer = "GeForce 9600M GT/PCI/SSE2";
 $pref::Video::profiledVendor = "NVIDIA Corporation";
 $pref::Video::resolution = "1024 768 32";
 $pref::Video::safeModeOn = "1";


Index: opera.slinger/server/scripts/gameManager.cs
===================================================================
--- opera.slinger/server/scripts/gameManager.cs       (.../operaslinger)
        (revision 1)
+++ opera.slinger/server/scripts/gameManager.cs
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)
@@ -192,8 +192,9 @@
                        playGuiUpdate($gameManagerState);
                        $Aria.initAriaMouthSequence( $currentTrigger );
             %songNum = PitchDetector_GetSongNum();
+                       %fileTimeStamp = getRealTime();
             $therapyDataFile.close();
-            $therapyDataFile =
openWriteFile("opera.slinger/data/gameData/TherapyDataSong" @ %songNum @
".txt");
+            $therapyDataFile = openWriteFile("opera.slinger/data/gameData/"
@ %fileTimeStamp @ "TherapyDataSong" @ %songNum @ ".txt");
                        PitchDetector_Start();
                        $gameManagerState = $managerInSingOff;


Index: opera.slinger/globals.cs
===================================================================
--- opera.slinger/globals.cs   (.../operaslinger)     (revision 1)
+++ opera.slinger/globals.cs
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)
@@ -21,7 +21,7 @@
```

```
        $loseScreenDelay = 1000;
        $mainMenuDelay = 5000;


-       $popUpInGameDelay = 3000;
+       $popUpInGameDelay = 4000;

 //-----------------------
 //           Camera Path Names
@@ -69,7 +69,7 @@
 //     Pitch Globals
 //---------------------
 //     PitchDetector_SetFormat( _samplesPerBuf, _samplesPerSecond,
_fftPoints, _bitsPerSample   );
-       $RecordingFormat =          "1024 11025 2048 16";
+       $RecordingFormat =          "1024 44100 2048 16";
        $VolumePercentThreshold = 0.025;                              // i.e.
0.10 -> 10%
        // These are different for each difficulty
        // Gain is like inverse smoothness.  The lower the gain: (1) the
higher the smoothness (2) the slower the response time of the arrow
@@ -88,7 +88,7 @@
 //--------------------------
        $NoteRange = 3.0;              // The bounds (in terms of note
indecies) for player to recieve points
        // amount to offset the singer's octave ( positive - raises the
singer's octave, negative - lowers the singer's octave )
-       $MaleOctaveOffset = 1;         // if male
+       $MaleOctaveOffset = 0;         // if male
        $FemaleOctaveOffset = 0;                // if female

        // Accuracy % (the higher the %, the closer the player has to be to
the real note)
@@ -105,7 +105,7 @@
 //           Points system percentage adjustment
 //---------------------
    // this is the amount of adjustment. For example - forte is singing at
50% of the accuracy, 0.25 would put him to 75%
-   $pointSystemAdjustmentEasy = 0.28;
+   $pointSystemAdjustmentEasy = 0.42;
    $pointSystemAdjustmentMedium = 0.13;
    $pointSystemAdjustmentHard = 0.0;
    // default, will get set by the difficulty select screen


Index: opera.slinger/data/gameData/song2.info
===================================================================
--- opera.slinger/data/gameData/song2.info   (.../operaslinger)    (revision
1)
+++ opera.slinger/data/gameData/song2.info
       (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
       (revision 36)
@@ -1,3 +1,2 @@
-You're About to Sing...
-Eine Kleine Nachtmusik
-By: Mozart
+You're About to
```

```
+repeat momomomo.....


Index: opera.slinger/data/gameData/song4.info
===================================================================
--- opera.slinger/data/gameData/song4.info    (.../operaslinger)    (revision
1)
+++ opera.slinger/data/gameData/song4.info
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)
@@ -1,3 +1,3 @@
-You're About to Sing...
-The Four Seasons - Spring
-By: Vivaldi
+You're About to hum...
+London Bridge is falling down
+using a "mo"


Index: opera.slinger/data/gameData/song1.note
===================================================================
--- opera.slinger/data/gameData/song1.note    (.../operaslinger)    (revision
1)
+++ opera.slinger/data/gameData/song1.note
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)
@@ -1,47 +1,63 @@
-4      830     5580    1
-4      620     6510    1
-4      210     7200    0.8
-4      620     7440    1
-2      210     8130    0.8
-0      620     8370    1
--3     210     9060    0.8
--4     620     9300    1
--1     210     10000   0.8
-2      500     10230   1
-5      210     10750   0.8
-4      830     11160   1
-0      830     12090   1
-4      830     13020   1
-4      620     13950   1
-4      210     14650   0.8
-4      620     14880   1
-2      210     15580   0.8
-0      620     15810   1
--3     210     16510   0.8
--4     620     16740   1
--1     210     17440   0.8
-2      620     17670   1
-5      210     18370   0.8
-4      410     18600   1
-0      410     19060   1.02
-4      410     19530   1.04
-0      410     20460   1.06
-2      410     21390   1.08
```

```
--1     410     22320   1.1
-0      410     22790   1.12
--3     410     23250   1.14
--1     410     23720   1.16
--3     1400    24180   1.05
-4      830     26040   1.1
-4      620     26970   1.2
-4      210     27670   0.8
-4      620     27900   1.2
-2      210     28600   0.8
-0      400     28830   1.2
--3     210     29530   0.8
--4     620     29760   1.1
--1     210     30460   0.8
-2      350     30690   1
-5      210     31150   0.8
-4      830     31620   1
-0      2000    32550   1.25
+4      200     4000    0
+4      200     4500    0
+4      200     5000    0
+4      200     5500    0
+2      200     6000    0
+
+-3     250     7000    0.5
+-4     150     7300    0.5
+-1     400     7600    0.5
+2      400     7900    0.5
+5      500     8500    0.5
+4      600     9100    0.5
+
+
+4      150     9200    0.8
+4      150     9450    0.8
+4      500     9950    0.8
+2      400     10550   0.8
+0      350     11050   0.8
+-3     650     11850   0.8
+
+-1     150     12000   0.5
+2      100     12300   0.5
+5      400     12800   0.5
+4      410     13400   0.8
+0      450     14100   0.8
+4      460     14800   0.5
+0      520     15500   0.5
+
+
+0      220     15800   0.5
+-3     100     16100   0.8
+-1     350     17000   1.0
+-1     400     17800    0.8
+-3     400     18600   0.8
+4      600     18800   0.5
+
+
```

```
+-3      250      22000    0.5
+-4      150      22250    0.5
+-1      400      22400    0.5
+2       400      22900    0.5
+5       500      23500    0.5
+4       600      23300    0.5
+
+
+4       150      24000    0.8
+4       150      24150    0.8
+4       500      24650    0.8
+2       400      25550    0.8
+0       350      26250    0.8
+-3      650      27000    0.8
+
+-1      150      27500    0.5
+2       100      27800    0.5
+5       400      28400    0.5
+4       410      29000    0.8
+0       450      29700    0.8
+4       460      30300    0.5
+0       520      31100    0.5
+
+0       220      31200    0.5
+-3      100      31500    0.8
\ No newline at end of file


Index: opera.slinger/data/gameData/song3.note
================================================================
--- opera.slinger/data/gameData/song3.note     (.../operaslinger)     (revision
1)
+++ opera.slinger/data/gameData/song3.note
       (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
       (revision 36)
@@ -1,48 +1,66 @@
-3       300      9540     0.8
-3       300      9990     0.8
-3       460      10400    1
-6       350      10870    0.9
-4       100      11220    0.7
-1       810      11330    1
-1       320      12250    0.8
-1       280      12700    0.7
-1       430      13140    1
-4       330      13590    0.9
-3       110      13940    0.7
--1      910      14060    1.2
-3       410      14970    0.9
-1       440      15390    0.9
--1      230      15850    0.8
--1      340      16310    1
--2      100      16680    0.7
--2      820      16810    1.25
-0       0        17670    0
-0       0        18120    0
```

```
-0      0       18570   0
-0      0       19020   0
-0      0       19400   0
-0      0       19540   0
-3      300     23180   0.9
-3      300     23630   0.9
-3      430     24040   1
-6      340     24500   1.1
-4      90      24860   0.7
-1      750     24960   1.3
-1      320     25890   1
-1      280     26340   0.9
-1      430     26770   1
-4      320     27230   0.9
-3      100     27570   0.7
--1     780     27700   1.35
-3      400     28610   1
-1      430     29030   1
--1     230     29490   0.9
--1     360     29940   0.8
--2     100     30320   0.7
--2     780     30450   1.4
-1      420     31310   1
--1     420     31750   1
--4     310     32210   0.8
--4     350     32660   0.9
--6     100     33040   0.7
--6     1400    33180   1.5
+3      300     10000   1
+3      300     11000   1
+3      300     12000   1
+3      300     13000   1
+3      300     14000   1
+
+
+
+
+2      200     20300   .8
+2      200     20600   .8
+2      200     20900   .8
+2      200     21200   .8
+2      200     21500   .8
+3      200     21800   0.8
+3      200     22100   0.8
+3      200     22400   .8
+6      200     22700   .8
+4      200     23000   0.8
+1      200     23300   .8
+1      200     23600   .8
+1      200     23900   0.8
+
+
+
+3      200     24900   .8
+1      200     25100   .8
+-1     200     25400   0.8
```

```
+-1      200      25700   0.8
+-2      200      26000   0.8
+-2      200      26300   .8
+1       200      26700   .8
+
+
+
+-6      200      27700   .8
+1       200      28000   .8
+1       200      28600   .8
+4       200      28900   .8
+3       200      29200   .8
+-1      200      29500   .8
+3       200      29800   .8
+
+
+
+-2      200      30800   .8
+-2      200      31300   .8
+-1      200      31600   .8
+3       200      31900   .8
+1       200      32400   .8
+-1      200      32800   0.8
+-1      200      33200   .8
+
+
+
+3       200      33200   .8
+1       200      33600   .8
+-1      200      34000   0.8
+-1      200      34400   .8
+-2      200      34800   .8
+-2      200      35200   .8
+-2      200      35800   .8
+-2      200      36200   .8
+-2      200      36400   .8
+-2      200      36800   .8
+-2      200      37200   .8
\ No newline at end of file


Index: opera.slinger/data/gameData/song5.note
======================================================================
--- opera.slinger/data/gameData/song5.note    (.../operaslinger)    (revision
1)
+++ opera.slinger/data/gameData/song5.note
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)
@@ -1,48 +1,59 @@
-7       200      3860    1
-7       200      4090    1
-7       210      4310    1
-3       2600     4540    1.5
-5       200      7500    1
-5       210      7720    1
-5       210      7950    1
```

```
−2      2640    8180    1.6
−7      210     11130   1
−7      200     11360   1
−7      200     11590   1
−3      210     11810   1
−8      210     12040   1
−8      200     12270   1
−8      200     12500   1
−7      210     12720   1
−15     210     12950   1.1
−15     200     13180   1.2
−15     210     13400   1.3
−12     820     13630   1.5
−7      200     14770   1
−7      200     15000   1
−7      210     15220   1
−2      210     15450   1
−8      200     15680   1
−8      210     15900   1
−8      210     16130   1
−7      200     16360   1
−17     200     16590   1
−17     210     16810   1
−17     210     17040   1
−14     820     17270   1.7
−19     210     18150   1
−19     210     18400   1
−17     200     18650   1
−15     820     19090   1.8
−14     200     20000   1
−19     210     20220   1
−19     210     20450   1
−17     200     20680   1
−15     820     20900   1.85
−14     210     21810   1
−19     210     22040   1
−19     210     22270   1
−17     200     22500   1
−15     910     22720   1.9
−12     910     23630   1.95
−19     3180    24540   2
+3      400     3500    1
+3      400     4000    1
+3      400     4500    1
+3      400     5000    1
+
+
+
+3      400     7000    1
+3      400     7500    1
+3      400     8000    1
+3      400     8500    1
+3      400     9000    1
+3      400     9500    1
+3      400     10000   1
+3      400     10500   1
```

```
+3      400     11000   1
+3      500     11500   1
+
+
+
+
+3      500     12500   1
+3      500     13000   1
+3      500     13500   1
+3      500     14000   1
+3      500     14500   1
+3      500     15000   1
+3    500 15500  1
+3    500 16000     1
+
+
+
+
+
+3      500     17000   1
+3      500     17500   1
+3      500     18000   1
+3      500     18500   1
+3      500     19000   1
+3      500     19500   1
+3      500     20000   1
+3      500     20500   1
+3      500     21000   1
+3      500     21500   1
+3      500     22000   1
+
+
+
+
+3      500     23500   1
+3      500     24000   1
+3      500     24500   1
+3      500     25000   1
+3      500     25500   1
+3      500     26000   1
+3      500     26500   1
+3      500     27000   1
+3      500     27500   1
+3      500     28000   1
\ No newline at end of file


Index: opera.slinger/data/gameData/song1.info
===================================================================
--- opera.slinger/data/gameData/song1.info    (.../operaslinger)    (revision
1)
+++ opera.slinger/data/gameData/song1.info
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)
@@ -1,2 +1,3 @@
-You're About to Sing...
```

62

```
-Beethoven's Fifth
+You're About to sustain
+the "m" sound for as long as
+you can.



Index: opera.slinger/data/gameData/song3.info
===================================================================
--- opera.slinger/data/gameData/song3.info    (.../operaslinger)    (revision
1)
+++ opera.slinger/data/gameData/song3.info
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)
@@ -1,3 +1,3 @@
-You're About to Sing...
-La Donne e Mobile
-By: Verdi
+You're About to hum...
+Twinkle Little Star
+using a "mo"
\ No newline at end of file



Index: opera.slinger/data/gameData/song5.info
===================================================================
--- opera.slinger/data/gameData/song5.info    (.../operaslinger)    (revision
1)
+++ opera.slinger/data/gameData/song5.info
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)
@@ -1,3 +1,2 @@
-You're About to Sing...
-Beethoven's Fifth
-By: Beethoven!
\ No newline at end of file
+You're About to repeat
+4 phrase.
\ No newline at end of file



Index: opera.slinger/data/gameData/song2.note
===================================================================
--- opera.slinger/data/gameData/song2.note    (.../operaslinger)    (revision
1)
+++ opera.slinger/data/gameData/song2.note
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)
@@ -1,60 +1,41 @@
-2      450     8000    1
--3     220     8750    0.8
-2      450     9000    1
--3     220     9750    0.7
-2      220     10000   0.8
--3     220     10250   0.9
-2      220     10500   1
-6      220     10750   1.1
```

-9	450	11000	1.2
-0	0	12000	0
-0	0	12750	0
-0	0	13000	0
-0	0	13750	0
-0	0	14000	0
-0	0	14250	0
-0	0	14500	0
-0	0	14750	0
-0	0	15000	0
-2	220	16000	0.8
-2	670	16500	1
-6	220	17250	0.7
-4	220	17500	0.8
-2	220	17750	0.9
-2	220	18000	1
-1	220	18250	1
-1	670	18500	1.1
-4	220	19250	0.7
-7	220	19500	0.8
-1	220	19750	0.9
-4	220	20000	1
-2	220	20250	1
-2	670	20500	1.1
-6	220	21250	0.7
-4	220	21500	0.8
-2	220	21750	0.9
-2	220	22000	1
-1	220	22250	1
-1	670	22500	1.1
-4	220	23250	0.7
-7	220	23500	0.8
-1	220	23750	0.8
-2	220	24000	0.8
-2	220	24250	0.7
-2	110	24500	0.6
-1	110	24620	0.6
--1	110	24750	0.6
-1	110	24870	0.6
-2	220	25000	0.7
-2	220	25250	0.8
-6	110	25500	0.6
-4	110	25620	0.6
-2	110	25750	0.6
-4	110	25870	0.6
-6	220	26000	0.7
-6	220	26250	0.8
-9	110	26500	0.6
-7	110	26620	0.6
-6	110	26750	0.6
-7	110	26870	0.6
-9	400	27000	1.2
+3	300	9000	0.8
+3	300	9400	0.8
+3	300	9900	0.8
+3	300	10400	1

64

```
+
+
+3      200     15500   1
+3      200     16000   1
+3      200     16500   1
+3      200     17000   1
+3      200     17500   1
+3      200     18000   1
+3      200     18500   1
+3      200     19000   1
+3      200     19500   1
+3      200 20000       1
+3      200 20500       1
+3      200 21000       1
+
+3      200     22000   1
+3      200     22500   1
+
+
+
+
+
+
+3      200     24000   1
+3      200     24500   1
+3      200 25000       1
+3      200     25500   1
+3      200     26000   1
+3      200     26500   1
+3      200     27000   1
+3      200     27500   1
+3      200     28000   1
+3      200     28500   1
+3      200     29000   1
+3      200     29500   1
+
+3      200     30500   1
+3      200     31000   1
\ No newline at end of file


Index: opera.slinger/data/gameData/song4.note
===================================================================
--- opera.slinger/data/gameData/song4.note    (.../operaslinger)    (revision
1)
+++ opera.slinger/data/gameData/song4.note
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)
@@ -1,50 +1,69 @@
-0      240     12930   1
-7      240     13210   1
-5      120     13480   0.8
-4      120     13620   0.8
-5      240     13760   1
-7      240     14030   1.03
-9      240     14310   1.05
-7      490     14580   1.15
```

```
-0      240     15130   1
-7      240     15410   1
-5      120     15680   0.8
-4      120     15820   0.8
-5      240     15960   1
-7      240     16230   1
-9      240     16510   1
-7      490     16780   1.25
-0      240     17330   0.9
-9      240     17610   0.9
-7      490     17880   1.3
-5      240     18440   0.9
-4      240     18710   0.9
-2      120     18990   0.8
-0      120     19120   0.8
-2      490     19260   1.1
-0      1770    19810   1.5
-0      240     26140   1
-7      240     26420   1
-5      120     26690   0.9
-4      120     26830   0.9
-5      240     26970   1
-7      240     27240   1
-9      240     27520   1
-7      490     27790   1.3
-0      240     28340   1
-7      240     28620   1
-5      120     28890   0.9
-4      120     29030   0.9
-5      240     29170   1
-7      240     29440   1
-9      240     29720   1
-7      490     29990   1.5
-0      240     30550   1
-9      240     30820   1
-7      490     31100   1.2
-5      240     31650   1
-4      240     31920   1
-2      120     32200   1
-0      120     32330   1
-2      490     32470   1.3
-0      1770    33020   2
+3      300     11000   1
+3      300     11500   1
+3      300     12000   1
+3      300     12500   1
+3      300     13000   1
+3      300     13500   1
+
+
+7      200     14500   1
+3      200     14800   1
+7      200     15100   1
+5      200     15400   1
+4      200     15700   1
+5      200     16000   1
```

```
+7       200      16500    1
+
+9       200      17000    1
+7       200      17250    1
+0       200      17750    1
+
+9       200      18250    1
+7       200      18500    1
+5       200      19000    1
+
+4       200      19500    1
+2       200      19750    1
+3       200      20000    1
+2       200      20500    1
+3       200      20750    1
+3       200      21000    1
+7       200      21250    1
+
+5       200      21750    1
+4       200      22000    1
+5       200      22500    1
+7       200      22750    1
+
+9       200      23250    1
+7       200      23500    1
+3       200      23750    1
+7       200      24000    1
+5       200      24250    1
+4       200      24500    1
+
+5       200      25000    1
+7       200      25250    1
+9       200      25500    1
+7       200      25750    1
+8       200      26000    1
+9       200      26500    1
+7       200      26750    1
+
+5       200      26250    1
+4       200      26500    1
+2       200      26750    1
+2       200      27250    1
+2       200      28750    1
+3       200      29250    1
+3       200      29750    1
+
+7       200      30250    1
+5       200      30500    1
+4       200      30750    1
+5       200      31000    1
+7       200      31250    1
+9       200      31500    1
+7       200      31750    1
+3       200      32000    1
+7       200      32500    1
\ No newline at end of file
```

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```
Index: opera.slinger/data/gameData/song1.lyric
===================================================================
--- opera.slinger/data/gameData/song1.lyric   (.../operaslinger)     (revision
1)
+++ opera.slinger/data/gameData/song1.lyric
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)
@@ -1,47 +1,63 @@
-Now
-you
-will
-find
-my
-mu-
-sic's
-the
-great-
-est
-of
-its
-kind!
-Lights
-crowds
-and
-cheers
-are
-all
-I've
-known
-for
-man-
-y
-years -
-and
-you
-can't
-hope
-to
-take
-that
-a-
-way!
-Pres-
-tige
-you
-can't
-de-
-fend
-to-
-day
-you
-will
-meet
-your
```

```
-end!
+Hum
+Happy
+Birthday
+using
+a "mo"
+
+mo
+mo
+mo
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+mo
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Index: opera.slinger/data/gameData/song2.lyric
===================================================================
--- opera.slinger/data/gameData/song2.lyric    (.../operaslinger)    (revision
1)
+++ opera.slinger/data/gameData/song2.lyric
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)
@@ -1,60 +1,41 @@
-Ar-
-i-
-a
-Your
-songs
-are
-a
-dis-
-grace!
-For-
-te
-fool
-I'll
-put
-you
-in
-your
-place!
-You
-are
-a
-worth-
-less
-cast-
-a-
-way
-rel-
-ic
-of
-by-
-gone
-days
-Your
-mu-
-sic's
-al-
-ways
-wrong
-crowds
```

```
-hate
+Get
+ready
 to
-hear
-your
-s
-o
-o
-o
-o
-o
-o
-o
-o
-o
-o
-o
-o
-o
-o
-ngs!
+sing..
+
+
+Mary
+Mary
+mo
+mary
+banana
+nana
+no-
+nary
+me
+my
+mo
+mary
+
+Mar-
+ee
+
+
+
+
+
+Mary
+Mary
+mo
+mary
+banana
+nana
+no-
+nary
+me
+my
```

```
+mo
+mary
+
+Mar-
+ee

Index: opera.slinger/data/gameData/song2a.lyric
================================================================
--- opera.slinger/data/gameData/song2a.lyric  (.../operaslinger)    (revision
1)
+++ opera.slinger/data/gameData/song2a.lyric
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)
@@ -1 +1,9 @@
-
+mo
+mo
+mo
+mo
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+mo
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+mo
\ No newline at end of file


Index: opera.slinger/data/gameData/song3.lyric
================================================================
--- opera.slinger/data/gameData/song3.lyric   (.../operaslinger)    (revision
1)
+++ opera.slinger/data/gameData/song3.lyric
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)
@@ -1,60 +1,66 @@
-Back
-at
-a-
-ca-
-de-
-my
-You
-rose
-to
-in-
-fa-
-my
-Mock-
-ing
-me
-end-
-less-
- ly
- I
-did
-so
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72

-happ-
-il-
- y
-My
-con-
-stant
-en-
-e-
-my
-Seems
-like
-all
-you
-can
-be
-Can
-we
-try
-to
-get
-free
-Sad-
- ly
-it's
-un-
-like-
- ly
+Hum
+Twinkle
+Twinkle
+Little
+Star....

-
-
-
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-
-
-
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-
+
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+mo
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73

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```

Index: opera.slinger/data/gameData/song4.lyric
===
--- opera.slinger/data/gameData/song4.lyric   (.../operaslinger)   (revision 1)
+++ opera.slinger/data/gameData/song4.lyric
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)

```
@@ -1,50 +1,69 @@
-What
-life
+Hum
+London
+Bridge
 is
-it
-that
-we
-both
-lead?
-So
-what
-is
-it
-that
-we
-both
-need?
-It's
-sim-
-ple
-just
-tell
-me
-that
-I've
-won
-And
-now
-we
-are
-back
-at
-the
-start
-An
-ar-
-gu-
-ment
-    o-
-ver
-whose
-part
-NOT
-MY
-PART
-should
-come
-to
-a
-quick
-end
+Falling
+Down.....
```

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+mo
+mo
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Index: opera.slinger/data/gameData/song5.lyric
===================================================================
--- opera.slinger/data/gameData/song5.lyric    (.../operaslinger)    (revision
1)
+++ opera.slinger/data/gameData/song5.lyric
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)
@@ -1,48 +1,59 @@
-Our
-ri-
-val-
-ry
-E-
-ter-
-nal-
-ly
-We
-fight
+Repeat
+the
+following
+4 phrases...
+
+
+
+Nick
+never
+made
+mini
+maple
+muffins
+with
+mama
 and
-feud
-our
-great-
-est
-fear
-is
-be-
-ing
-booed
-For
-cheer-
-ing
-fans
-we
```

```
-draw
-our
-plans
+Mary.
+
+
+
+
+Many
+many
+moons
+ago
+mary
+went
 to
-ne-
-ver
-lose
-re-
-spect
-and
-fame
-in
 the
-great-
-est
-game
-on
-the
-ope-
-ra
-stage
-of
-life!
+movies
+
+
+
+Nicks
+mom
+made
+his
+favorite
+meal of
+meat
+loaf
+and
+mashed
+potatoes
+
+
+
+
+My
+mom
```

```
+made
+me
+make
+maple
+muffins
+for
+Mary and
+Matt
\ No newline at end of file
Index: opera.slinger/client/prefs.cs
===================================================================
--- opera.slinger/client/prefs.cs        (.../operaslinger)        (revision 1)
+++ opera.slinger/client/prefs.cs
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)
@@ -114,7 +114,7 @@
 $pref::Video::allowOpenGL = "1";
 $pref::Video::appliedPref = "1";
 $pref::Video::clipHigh = "0";
-$pref::Video::defaultsRenderer = "GeForce Go 7800 GTX/PCI/SSE2";
+$pref::Video::defaultsRenderer = "GeForce 9600M GT/PCI/SSE2";
 $pref::Video::defaultsVendor = "NVIDIA Corporation";
 $pref::Video::deleteContext = "1";
 $pref::Video::disableVerticalSync = 1;
@@ -123,7 +123,7 @@
 $pref::Video::monitorNum = 0;
 $pref::Video::only16 = "0";
 $pref::Video::preferOpenGL = "1";
-$pref::Video::profiledRenderer = "GeForce Go 7800 GTX/PCI/SSE2";
+$pref::Video::profiledRenderer = "GeForce 9600M GT/PCI/SSE2";
 $pref::Video::profiledVendor = "NVIDIA Corporation";
 $pref::Video::resolution = "1024 768 32";
 $pref::Video::safeModeOn = "1";


Index: opera.slinger/client/scripts/default.bind.cs
===================================================================
--- opera.slinger/client/scripts/default.bind.cs        (.../operaslinger)
        (revision 1)
+++ opera.slinger/client/scripts/default.bind.cs
        (.../operaslinger/branches/OperaSlingerRevised/1.0/operaSlinger)
        (revision 36)
@@ -12,6 +12,7 @@
 //---------------------------------------------------------------------------
----

 moveMap.bindCmd(keyboard, "escape", "", "eventManager(7);");
+
 //---------------------------------------------------------------------------
----
 // Movement Keys
 //---------------------------------------------------------------------------
----
@@ -201,3 +202,298 @@
 // cheat keys
 moveMap.bindCmd(keyboard, "alt 4", "cheat(20);", "");
```

```
 moveMap.bindCmd(keyboard, "alt 5", "cheat(21);", "");
+
+//function bindGamePadButtons()
+//{
+    echo("setting up bindGamePadButtons");
+
+   moveMap.bind(joystick, "xaxis", joymovex); //left stick
+   moveMap.bind(joystick, "yaxis", joymovey); //left stick
+   moveMap.bind(joystick, "zaxis", joyyaw);  //right stick
+   moveMap.bind(joystick, "rzaxis", joypitch); //right stick
+   moveMap.bind(joystick, button0, joybutton0 );
+   moveMap.bind(joystick, button1, joybutton1 );
+   moveMap.bind(joystick, button2, joybutton2 );
+   moveMap.bind(joystick, button3, joybutton3 );
+   moveMap.bind(joystick, button4, joybutton4 );
+   moveMap.bind(joystick, button5, joybutton5 );
+   moveMap.bind(joystick, button6, joybutton6 );
+   moveMap.bind(joystick, button7, joybutton7 );
+   moveMap.bind(joystick, button8, joybutton8 );
+   moveMap.bind(joystick, button9, joybutton9 );
+
+
+//POV works with TGE 1.4 not with T2D EA build
+
+   moveMap.bind(joystick, "upov", joypovup ); //POV up
+   moveMap.bind(joystick, "dpov", joypovdown ); //POV down
+   moveMap.bind(joystick, "lpov", joypovleft ); //POV left
+   moveMap.bind(joystick, "rpov", joypovright ); //POV right
+//}
+
+
+//Basic Functions - the will //echo to the console and console.log so you
can see what is working
+//Change the function contents to whatever you want
+
+
+//Left Stick
+function joymovex(%val)
+{
+   if ($playerCanMove)
+   {
+      //echo("Left stick x: "@%val);
+      if ($pref::Input::Deadzone < %val | - $pref::Input::Deadzone > %val)
+      {
+
+         if ($AIPlayer::PlayerHasMoved == false)
+         {
+             AIPlayer::flipPlayerHasMoved();
+         }
+           echo("Left Stick x: "@%val);
+           if (%val > 0)
+           {
+               $mvLeftAction = 0;
+               $mvRightAction = %val * $movementSpeed;
+               echo("Move right");
+           }
```

```
+            else
+            {
+                $mvRightAction = 0;
+                $mvLeftAction = (%val * $movementSpeed) * -1 ;
+                echo("Move left");
+            }
+        }
+        else
+        {
+            echo("Nothing Happening");
+            $mvRightAction = 0;
+            $mvLeftAction = 0;
+        }
+    }
+}
+
+function joymovey(%val)
+{
+    if ($playerCanMove)
+    {
+
+        if ($pref::Input::Deadzone < %val | - $pref::Input::Deadzone > %val)
+        {
+            if ($AIPlayer::PlayerHasMoved == false)
+            {
+                AIPlayer::flipPlayerHasMoved();
+            }
+            echo("Left Stick y: "@%val); //debugcode
+            if (%val > 0)
+            {
+                $mvForwardAction = 0;
+                $mvBackwardAction = %val * $movementSpeed;
+                echo("Move backward"); //debugcode
+            }
+            else
+            {
+                $mvBackwardAction = 0;
+                $mvForwardAction = (%val * $movementSpeed) * -1;
+                echo("Move forward");
+            }
+        }
+        else
+        {
+            echo("Nothing Happening");
+            $mvForwardAction = 0;
+            $mvBackwardAction = 0;
+        }
+    }
+}
+
+
+//Right Stick
+function joyyaw(%val)
+{
+    if ($playerCanMove)
+    {
```

```
+
+       echo("Right stick x: "@%val); //Debugcode
+       if ($pref::Input::Deadzone < %val | - $pref::Input::Deadzone > %val)
+       {
+            if (%val > 0)
+            {
+                $mvYawRightSpeed = 0;
+                $mvYawLeftSpeed = %val ? $globalGamePadTurnSpeed : 0;
+            }
+            else
+            {
+                $mvYawLeftSpeed = 0;
+                $mvYawRightSpeed = %val ? $globalGamePadTurnSpeed : 0;
+            }
+       }
+       else
+       {
+            $mvYawLeftSpeed = 0;
+            $mvYawRightSpeed = 0;
+       }
+    }
+}
+
+function joypitch(%val)
+{
+   if ( $playerCanMove)
+   {
+
+       echo("Right stick y: "@%val); //Dubug code
+       if ($pref::Input::Deadzone < %val | - $pref::Input::Deadzone > %val)
+       {
+            if (%val < 0)
+            {
+                $mvPitchUpSpeed = 0;
+                $mvPitchDownSpeed = %val ? $globalGamePadTurnSpeed : 0;
+            }
+            else
+            {
+                $mvPitchDownSpeed = 0;
+                $mvPitchUpSpeed = %val ? $globalGamePadTurnSpeed : 0;
+            }
+       }
+       else
+       {
+            $mvPitchUpSpeed = 0;
+            $mvPitchDownSpeed = 0;
+       }
+    }
+}
+
+
+//Buttons
+function joyButton0(%val)
+{
+   if ($playerCanMove)
+   {
```

```
+
+      if(%val)
+      {
+         eventManager(3);
+         echo("Button 0 pressed");
+      }
+
+   }
+}
+
+function joyButton1(%val)
+{
+   if ($playerCanMove)
+   {
+      if(%val)
+      {
+         $mvTriggerCount0++;
+         echo("Button 1 pressed");
+         if (%val)
+         {
+            $mvTriggerCount2+=2;
+         }
+      }
+
+   }
+}
+
+function joyButton2(%val)
+{
+   if(%val)
+   {
+      eventManager(5);
+      echo("Button 2 pressed");
+   }
+
+}
+
+function joyButton3(%val)
+{
+   if(%val)
+   {
+      echo("Button 3 pressed");
+      eventManager(4);
+   }
+
+}
+
+function joyButton4(%val)
+{
+   if(%val)
+   {
+      echo("Button 4 pressed");
+   }
+}
+
+function joyButton5(%val)
```

```
+{
+  if(%val)
+    {
+      echo("Button 5 pressed");
+    }
+}
+
+function joyButton6(%val)
+{
+  if(%val)
+    {
+      echo("Button 6 pressed");
+    }
+}
+
+function joyButton7(%val)
+{
+  if(%val)
+    {
+      echo("Button 7 pressed");
+    }
+}
+
+function joyButton8(%val)
+{
+  if(%val)
+    {
+      echo("Button 8 pressed");
+    }
+}
+
+function joyButton9(%val)
+{
+  if(%val)
+    {
+      echo("Button 9 pressed");
+    }
+}
+
+
+//POV hat - //POV works with TGE 1.4 not with T2D EA build
+
+function joyPOVUp(%val)
+{
+   if(%val)
+     {
+       echo("d-pad up pressed");
+     }
+}
+
+function joyPOVDown(%val)
+{
+   if(%val)
+     {
+       echo("d-pad down pressed");
+     }
```

```
+}
+
+function joyPOVLeft(%val)
+{
+    if(%val)
+    {
+        echo("d-pad left pressed");
+    }
+}
+
+function joyPOVRight(%val)
+{
+    if(%val)
+    {
+        echo("d-pad right pressed");
+    }
+}
```

APPENDIX F: IRB PERMISSION LETTER

EXPEDITED CONTINUING REVIEW APPROVAL NOTICE

From : **UCF Institutional Review Board**
        FWA00000351, Exp. 10/8/11, IRB00001138

To   : Bari H. Ruddy and Denise M. Nicholson

Date : **April 22, 2009**

IRB Number: SBE-07-05313

Study Title: **Treating Voice Disorders in School Age Children in a Gaming Environment**

Dear Researcher,

This letter serves to notify you that the continuing review application for the above study was reviewed and approved by the IRB Chair on 04/22/2009 through the expedited review process according to 45 CFR 46 (and/or 21 CFR 50/56 if FDA-regulated). The deletion of Jennifer Vogel-Walcutt as co-investigator to this research was noted.

Continuation of this study has been approved for a one-year period. The expiration date is 04/21/2010. This study was determined to be no more than minimal risk and the category for which this study qualified for expedited review is:

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Use of the approved, stamped consent document(s) is required. The new forms supersede all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Subjects or their representatives must receive a copy of the consent form(s).

All data must be retained in a locked file cabinet for a minimum of three years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

To continue this research beyond the expiration date, a Continuing Review Form must be submitted 2 – 4 weeks prior to the expiration date. Use the Unanticipated Problem Report Form or the Serious Adverse Event Form (within 5 working days of event or knowledge of event) to report problems or events to the IRB. Do not make changes to the study (i.e., protocol methodology, consent form, personnel, site, etc.) before obtaining IRB approval. Changes can be submitted for IRB review using the Addendum/Modification Request Form. An Addendum/Modification Request Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

On behalf of Tracy Dietz, Ph.D., UCF IRB Chair, this letter is signed by:

Signature applied by Janice Turchin on 04/22/2009 12:37:31 PM EDT

IRB Coordinator

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