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# The Treatment Efficacy of the Slurp-swallow Exercise in Strengthening the Tongue in Persons with Tongue Thrust

By

Misty S. Torrey

**A thesis submitted in partial fulfillment**
**of the requirements for the degree of**
**Master of Science in the Department of**
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**Idaho State University**
**November 2013**

## Committee Approval

To the Graduate Faculty:

The members of the committee appointed to examine the thesis of Misty S. Torrey find it satisfactory and recommend that it be accepted.

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April 12, 2013

Tony Seikel
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RE: Your application dated 4/12/2013 regarding study number 3881M4: The Treatment Efficacy of the Oromyofunctional Exercise in Strengthening the Tongue in Persons with Tongue Thrust

Dear Dr Seikel:

Thank you for your response to requests from a prior review of your application for the new study listed above.

You are granted permission to conduct your study as most recently described effective immediately. The study is subject to continuing review on or before 4/12/2014, unless closed before that date.

Notify the HSC of any adverse events. Serious, unexpected adverse events must be reported in writing within 10 business days.

Submit progress reports on your project in six months. You should report how many subjects have participated in the project and verify that you are following the methods and procedures outlined in your approved protocol. Then, report to the Human Subjects Committee when your project has been completed. Reporting forms are available on-line.

Please note that any changes to the study as approved must be promptly reported and approved. Some changes may be approved by expedited review; others require full board review. Contact Patricia Hunter (208-282-2179; fax 208-282-4723; email: humsubj@isu.edu) if you have any questions or require further information.

Sincerely,

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## Abstract

Research regarding the effectiveness of specific exercises used for the treatment of tongue thrust is limited, though overall efficacy of treatment is well documented. A quasi-multiple baseline across behaviors model replicated across subjects was utilized in the current study to investigate if the slurp-swallow exercise would increase the superior lingual force exerted by the tongue during 10 treatment sessions as previously supported by Buchanan in 2008. Three adults and one child participated in this study. In all four cases superior lingual force increased during the 10 treatment sessions and was maintained for 2-8 weeks following cessation of treatment.

## Chapter I-Introduction and Review of Literature

From a developmental standpoint, swallowing can be divided into two pattern types: visceral and somatic. During the visceral stage of development, which is the typical swallowing pattern for infants, the tongue moves forward and back along a horizontal plane (Horn, Kühnast, Axmann-Krcmar, Göz, 2004). The somatic swallow pattern emerges after the first few years of life and as the deciduous teeth descend the visceral swallow is gradually replaced by the somatic swallow (Horn et al. 2004; Rakosi, Jonas & Graber, 1993). The somatic pattern results in the bolus being moved to the oropharynx as the masticatory muscles contract to bring the teeth together. The dorsum of the tongue quickly moves superiorly, which then compresses against the hard palate effectively squeezing the bolus posteriorly (Horn et al., 2004). It is common for the somatic swallow pattern to not be well established until a child is within the fourth year of life (Peng, Jost-Brickmann, Yoshida, Miethke, & Lin, 2003). Generally speaking, the retention of the visceral swallow pattern beyond what is expected developmentally is commonly referred to as tongue thrust, and is considered to be an orofacial myofunctional disorder.

Many specific definitions of tongue thrust have been proposed. Hanson and Barrett (1988, p. 5) offered this definition: "Habitual resting or pushing of the tongue against at least ½ of the lingual surface area of the incisors or cuspids, or protrusion between the upper and lower anterior teeth." In 2003, Robert Hanson along with Marvin Mason published an updated definition to include movement and swallowing.

*"when, during the moving or swallowing of any 2 of these 3 media (liquids, solids, saliva) there is an observable increase of (1) force, (2) degree of protrusion, or (3) amount of surface area of the teeth contacted by the tongue."*

Tongue thrust is also known as infantile swallow, deviant swallow, or perverted swallow (Fraser, 2006; Hanson & Barrett, 1988). Tongue thrust interrupts the normal process of the oral cavity and it is linked to malocclusion of teeth and possibly articulation errors (Seikel, King & Drumright, 2005). Therapy to remediate tongue thrust is often referred to as either orofacial myofunctional therapy or myofunction therapy. This orofacial myofunctional therapy is within the scope and practice of the speech language pathologist (ASHA, 1993). The American Speech-Language-Hearing Association (ASHA) acknowledges the need for treatment of tongue thrust and charges speech-language pathologists with carrying out this therapy through the Preferred Practices Patterns for the Profession of Speech Language Pathology published in 2004.

There is a growing body of evidence supporting the benefits of oromyofunctional therapy. However, there is currently a paucity of evidence that speech-language pathologists can use to determine which specific exercises should be included in the treatment of tongue thrust (Ferreira, Mangill, Sassi, Fortunato-Tavares, Limongi, Furqui, de Andrade, 2011). Understanding the effectiveness of specific exercises serves to increase the ability of speech-language pathologists to employ evidence based practice in the treatment of tongue thrust. The slurp-swallow is one of many exercises that have traditionally been used in therapy to remediate treat tongue thrust. In 2007, Alixandrea Buchanan conducted research which sought to determine if the slurp-swallow exercise

increased lingual strength. Buchanan hypothesized that lingual strength would increase with the practice of the slurp-swallow exercise. The research hypothesis of the Buchanan study was supported by the results of three of the four participants. Preliminary data that supports the use of the slurp-swallow exercise in tongue thrust remediation programs were provided from that prior study (Buchanan, 2007). The current study sought to further add to the evidence of the effect of the slurp-swallow on lingual strength.

***Normal Deglutition***

In order to fully understand the disordered swallow it is important to first have a full understanding of the normal swallow (Knosel, Klein, Bleckmann, & Engelke, 2011; Logemann, 1998; Matsuo & Palmer, 2008). In the typical swallow, in order to contain and propel the bolus from the oral cavity into the pharynx the tongue must move through a series of rapid shape changes (Knosel, et al., 2011). It requires the central and peripheral nervous systems, as well as the jaw, tongue, teeth, pharynx, and larynx, all moving in controlled and precise coordination (Van den Engel-Hoek, de Groot, Esser, Gorissen, Hendriks, de Swart, & Geurts, 2012). In 2001, André Jean described swallowing as constituting "one of the most elaborate motor functions, even in humans" (Jean, 2001). The motor act of swallowing requires the sequential activation of inhibition of more than 25 pairs of muscles bilaterally (Jean, 2001). Swallowing is controlled by a central pattern generator (Jean, 2001; Restivo, Marchese-Ragona & Patti, 2006; Tsukano, Taniguchi, Hori, Tsujimura, Nakamura, & Inoue, 2012). The central pattern generator or CPG of swallowing can be organized into three subsystems: the afferent, the efferent and the organizing system (Jean 2001). The afferent system is responsible for the central and peripheral inputs to the swallowing system while the efferent system consists of motor

neuron pools that are responsible for the outputs of the swallowing system. The interneuronal network that programs the motor pattern of the swallow is controlled by the organizing system (Jean 2001). The CPG is made up of a complex pool of interconnected and interacting neurons that are housed within the medulla oblongata. The intricacies of the CPG are still being explored, while we must understand that the stimulation of peripheral nerves sends signals to the CPG which directs the sequence of swallowing, the true complexities of this sophisticated system are beyond the scope of this paper (Jean, 2001; Restivo, et al., 2006; Tsukano, et al., 2012). We must also understand that swallowing is a primal reflex, present even as early as the 12$^{th}$ week gestation before the development of the cortical and subcortical structures (Jean, 2001).

As, has been established, swallowing is an elaborate series of events that occur with very little thought. Beyond the neurophysiological initiation, sequencing and control of the swallowing, it is important to examine and understand the sequence and stages of the swallow, in order to appreciate the impact that breakdowns in the system can have.

There has existed some debate as to the stages which exist within the normal swallow. Some authors have proposed as many as six stages while others have suggested as few as two (Leopold, 1997). Contemporary thinking generally accepts the division of the normal swallow into at least the three distinct phases: the oral phase, the pharyngeal phase and finally the esophageal phase. The oral phase can be further divided into the oral preparatory phase and the oral phase (Logemann, 1998; Seikel, et al., 2009; Tutor & Gosa, 2011; Weckmueller et al., 2009).

The oral preparatory phase begins with the sensory recognition of the presence of food. Once the food has been placed within the oral cavity the lips close to encapsulate the food, thus ensuring no food or liquid escapes from the mouth. While the lips are firmly closed, the nasal airway must be open to allow for nasal breathing. Depending on the consistency of the material there will be some degree of oral manipulation which may include tongue manipulation of the bolus or mastication. If mastication is not required, as in the case of a liquid bolus, the tongue will immediately begin to move the material posteriorly once control of the bolus has been obtained, triggering the oral phase of the swallow. If mastication is required the tongue positions the food on the teeth and the teeth crush the material, which then moves medially back to the tongue. This process will be repeated as the tongue and teeth work in coordination to add saliva and create the homogenous consistency from which the bolus is formed. During this process the pharynx and the larynx are at rest. The tongue begins to move posteriorly as it gains control of the now well-formed bolus, triggering the oral phase of the swallow (Logemann, 1998; Seikel, et al., 2009).

During the oral phase, which typically lasts only 1-1.5 seconds, the tongue moves superiorly towards the hard palate which presses the bolus anteriorly towards the pharynx. The pressure required to move the bolus into the pharynx is dependent upon the viscosity. As the bolus reaches the faucial pillars the afferent fibers are stimulated, initiating a synaptic response at which point the CPG activates the swallow sequence (Logemann, 1998; Jean, 2001; Seikel et al., 2000; Van den Engel-Hoek, et al., 2012).

The pharyngeal phase of swallowing begins at this point. In a rapid and coordinated fashion, a sequence of specifically timed reflexively controlled events takes

place. Respiration is halted, with both oral and nasal airway being occluded. Airway protection is achieved by the adduction of the vocal folds, followed by the false vocal folds and the depression of the epiglottis. The larynx elevates and moves forward as the mylohyoid, digastric, and geniohyoid muscles work to move the hyoid both anteriorly and superiorly. The cricopharyngeus muscle relaxes to allow the opening of the upper esophageal sphincter. The bolus is forced into the oropharynx as the posterior faucial pillars move medially. At nearly the same time the pharyngeal walls constrict and the tongue base retracts to contact the pharyngeal walls. The pharyngeal constrictors begin a top to bottom compression which moves the bolus towards the larynx. In order to navigate around the larynx the bolus is divided into two roughly equal portions that descend into the pyriform sinuses on either side of the larynx. The bolus recombines at the esophageal entrance where the esophageal phase begins (Logemann, 1998; Seikel et al., 2000; Van den Engel-Hoek, et al.; 2012; Wilson, & Green, 2006). A peristaltic wave moves the bolus through the esophagus until it reaches the lower esophageal sphincter that opens to allow the bolus to enter the stomach. The transit time for the bolus to reach the stomach is about 10-20 seconds. Once the bolus enters the esophagus the cricopharyngeus contracts once again, the larynx and soft palate depress and respiration will resume (Logemann, 1998; Seikel et al., 2000).

***Maturation of the Normal Swallow***

Unlike pharyngeal function which is fully mature at birth in order to ensure life-sustaining functions such as breathing; the anatomy and function of the oral cavity develop throughout early childhood (Matsuo & Palmer, 2008; Stahl, Grabowski, Gaebel, & Kundt, 2006). Logemann describes the anatomical and physiological differences

between infant and adult oral structures (1998). Unlike adults, the infant tongue fills the oral cavity and fat pads line the cheeks to narrow the cavity laterally. The larynx and hyoid bone are positioned more superiorly in infants, resulting in greater protection of the airway. Also, in infants, the velum hangs lower and the uvula can often be seen resting inside the epiglottis (Logemann, 1998). In addition, to anatomical differences between infants and adults, there are swallow pattern differences between the two age groups (Logemann, 1998). Of great importance to this study is the normal development of the swallow, including the transition from visceral swallow to somatic swallow and deviations from that development.

The reflex to suck when the hard palate is stimulated develops early in gestation, fetuses can be seen to swallow amniotic fluid during ultrasound examinations as early as 12 weeks gestation (Leopold & Daniels, 2010; Jean, 2001). The first stage in the post-natal development of swallowing is suckling. Suckling has a distinct front to back movement that develops around the $18^{th}$ to $24^{th}$ week of gestation (Leopold & Daniels, 2010). During suckling a licking motion is used to draw the liquid into the mouth and the jaw is used to create pressure changes as it opens and closes with pronounced movement. During suckling the tongue protrusion does not extend beyond the lips (Arvedson & Brodsky, 2002). According to Ehrlic (1973), the jaw is slightly open and the circumoral muscles are engaged during the infantile swallow. The muscles of mastication are responsible for stabilizing the position of the mandible. The tongue is spread between the gum pads as the muscles of the lips and cheeks contract. Increased use of the temporal and masseter muscles is noted as dentition erupts (Ehrlich, 1973).

Sucking develops at approximately 6 months of age (Arvedson & Brodsky, 2002). In contrast to suckling, the jaw moves less vertically as the tongue is now responsible for creating the pressure changes needed to draw liquid in (Arvedson & Brodsky, 2002, Logemann, 1998). Transitional feeding begins around the same time as the child transitions from suckling to sucking (Arvedson & Brodsky, 2002). According to Arvedson and Brodsky (2002), transitional feeding occurs for normally developing children at approximately 4-6 months of age. Changes in the central nervous system in addition to anatomical changes occur as the child matures. Intraoral space increases, the mandible grows in downward and forward direction, the hyoid and larynx move inferiorly and the fat pads that once lined the cheeks are absorbed. This period is considered to be developmentally critical or sensitive for the initiation to varied textures of foods. If the exposure to varied textures is withheld normally developing as well as developmentally delayed children are more likely to face difficulty in accepting solids. Deciduous teeth begin to erupt at this time as well and by the second year the child should have all 20 deciduous teeth (Arvedson & Brodsky, 2002). The transition from visceral to somatic swallow occurs gradually in the first few years of life. The maturation of feeding abilities during early childhood is largely influenced by development of the central nervous system and experiential learning (Stevenson & Allaire, 1991).

***Oromyofunctional Disorders***

Abnormal patterns of the oral and facial structures that negatively impact dentition, deglutition, and articulation are considered oromyofunctional disorders (Hanson & Mason, 2003). Tongue thrust is one such manifestation of these abnormal patterns. Orofacial myology is the term used to describe the study of patterns of use and

the relationship between dentition, speech, and vegetative functions. ASHA indicates the orofacial myofunctional therapy is indicated for individuals over the age of 4 years when the ability to speak or swallow is affected by "orofacial myofunctional disorder and when there is a reasonable expectation of benefit to the individual in body structure/function and/or activity/participation" (ASHA, 2004, p. 113). ASHA (2004, p. 114) includes in the Patterns of Preferred Practice clinical process for intervention to include, when indicated necessary by assessment:

- *The alteration of lingual and labial resting postures.*
- *Muscle retraining exercises.*
- *Modification of handling and swallowing of solids, liquids, and saliva.*

Tongue thrust has been associated with dental malocclusions (Dixit & Shetty, 2013; Seikel et al., 2005; Hanson, 1976). Additionally, tongue thrust is associated with open mouth posture, which in turn is associated with long facial pattern and proclination or pushing forward of upper anterior teeth (Dixit & Shetty, 2013). Articulation errors are highly associated with a tongue thrust swallow (Christensen, & Mason, 1981; Ward, Malone, Jann, Jann, 1961).

While it currently understood the discipline of orofacial myology is within the scope and practice of the speech-language pathologist, when compared to others in the field of speech language pathology, this discipline is a relatively young one (Hanson & Mason, 2003). According to Hanson and Mason in their 2003 book, Orofacial Myology: International Perspectives, Second Edition, the discipline of orofacial myology emerged early in the twentieth century through a collection of written opinions based on facts gleaned from scientific research.

Despite the youth of orofacial myology in the field of speech language pathology we know the relationships between the muscular, skeletal and dental structures of the swallowing mechanism have long been studied. In 1899 Edward Angle published "Classification of Malocclusion" followed closely by the 6th edition of his book, "Treatment of the Teeth and Fractures of the Maxillae" in 1900 (Rinchuse & Rinchuse, 1988). Rinchuse and Rinchuse describe the evolution of Angle's understanding of the nature of malocclusions by noting that in 1907 Angle determined that emphasis should be placed on maxillary permanent first molars and canines in judging mesio-distal relationships. In earlier writings his emphasis was on all teeth, and although Angle continued to underscore the importance of considering all teeth when classifying malocclusions, he stressed the importance of these maxillary teeth (Rinchuse & Rinchuse, 1988). It was Edward H. Angle who developed a classification system for malocclusion, a classification system that is still in use today. Angle described a normal relationship between the dental arches as the mesiobuccal cusp of the upper first maxillary molar aligning with the buccal groove of the first mandibular molar.

In 1934 Strang described the persistent effort on the part of patients with malocclusion to conscientiously use the muscles correctly to overcome "perverted muscles action" (Strang, 1934).

James Brauer, D.D.S. and Townsend Holt, D.D.S. published a proposed classification system for tongue thrust in 1965, which included 4 types of tongue thrust each with subgroups. This system described the tongue thrust in terms of the location and degree of deformation that was noted in individuals with tongue thrust. Moyers

proposed a classification system that was more simplified which included only 3 classifications: simple, complex and retained infantile swallow (Moyers, 1988).

In 1963, Andersen described the relationship between tongue thrust syndrome, maturation and other factors. At that time, Andersen (1963) noted that the most reliable criterion for diagnosing tongue thrust syndrome was an anterior open bite. Anterior open bite is defined as an abnormal relationship between the upper incisors and the lower incisors in which the teeth in the maxilla do not occlude the teeth of the mandible. Andersen acknowledged that research regarding the association of Class II closed bite malocclusion or Class III malocclusion with tongue thrusting behaviors was emerging. He noted that a more involved examination or many sessions of working with these patients would be required before a positive diagnosis of tongue thrust syndrome could be made. Therefore, for the purpose of Andersen's study only subjects with an anterior open-bite were considered. Andersen examined the level of the hyoid bone in subjects with and without open anterior bite. Andersen determined that maturation contributed to spontaneous correction of tongue thrusting in some, but not all subjects. However, there was no evidence to support prediction of which subjects would do so.

Melsen, Attina, Santuari, and Attina examined 824 children between the ages of 13 and 14 from Northern Italy (Melsen, Attina Santuari & Attina, 1987). Simple tongue thrust was found in 8.3% of the children, and 11.9% of the total number of children exhibited a teeth apart or complex tongue thrust swallow. Children with a simple tongue thrust were found to have increased prevalence of overjet, crossbite and crowding up upper teeth. Those who exhibited a complex tongue thrust were found to

have an increased frequency of mandibular overjet and mesial molar occlusion (type II malocclusion) (Melsen et al., 1987).

In 1987, Andrianopoulos and Hanson conducted the final stage of a 14 year longitudinal study. The initial investigation conducted in 1967 included 225 randomly selected children with a mean age of 4 years 9 months. Over the course of several years the children were examined every 10 months until they reached the age of 8. At that time, 79% of the initial subjects were retained. Continued examinations of the subjects occurred at age 12 and age 18. Only 61 of the original 225 children were located at the age of 18. Of the remaining 61 subjects, Andrianopoulos and Hanson found that 42.6% (or 26 individuals) were diagnosed as having tongue thrust. The researchers found numerous developmental variations in the swallowing patterns of the 61 remaining subjects. From the 26 individuals demonstrating tongue thrust at the age of 18 only 4 were also found to have a tongue thrust swallow at both ages 4 and 8. Twelve of the twenty-six did however demonstrate a tongue thrust at age 4 only. At the age of 4, 18 individuals exhibited a tongue thrust, but by age 18 they exhibited a normal swallow pattern. Interestingly though, 14 subjects that demonstrated a normal swallow at age 4 now demonstrated a tongue thrust at age 18. Of those 61 subjects only one had a measurable open-bite at age 18. Twenty of the 61 subjects had received orthodontic treatment. Of these subjects nine (45%) were diagnosed with tongue thrust during this portion of the study. The remaining 41, who had not had orthodontic care, yielded 17 subjects or 41.5% with tongue thrust at the age of 18. Examinations at age eight indicated that 35% of subjects retained had tongue thrust, at age twelve the incident increased slightly to 38% and by age eighteen 42.6% of the remaining subjects

demonstrated tongue thrust. The results of this longitudinal study indicate that there is little evidence to predict the retention of tongue thrust. Therefore, the researchers concluded that an orthodontist presented with a patient with an overjet at age 8 has little information on which to make predictions regarding the retention of tongue thrust as the child matures (Andrianopoulos & Hanson, 1987).

Andrianopoulos and Hanson (1987), in the same paper, also examined the stability of overjet correction in those with tongue thrust who did not participate in therapy and those who did participate in therapy for the correction of the tongue thrust swallow. Tongue thrust has been one factor attributed to relapse to pre-treatment positions following orthodontia (Andrianopoulos & Hanson, 1987). The researchers randomly selected 17 subjects from the files of patients with tongue thrust from the University of Utah for whom a diagnosis of class II, division 1malocclusion prior to tongue thrust treatment was obtained from their orthodontist. These 17 individuals served as the "treatment" group. They randomly selected an additional 17 subjects who had received orthodontic treatment for the same class II, division 1 malocclusion, but who had not received tongue thrust therapy. The second group served as the "non-treatment" group. The researchers found that orthodontic treatment alone was not sufficient to correct tongue thrust as 12 of the 17 subjects in the non-treatment group continued to exhibit tongue thrust post orthodontic treatment. Tongue thrust treatment prior to orthodontic treatment was found to correct the tongue thrust as 14 of the 17 subject in the treatment group no longer exhibited tongue thrust after tongue thrust therapy followed by orthodontic treatment. The subjects in the treatment group exhibited less overjet relapse after orthodontia than those in the non-treatment group, supporting

the hypothesis that tongue thrust therapy followed by orthodontic treatment will result is better orthodontic outcomes (Andrianopoulos & Hanson, 1987).

More recent research has considered broader relationships between the dentition and the tongue than the earlier research by Andersen. When the anterior portion of the tongue at rest protrudes between or rests against more than one half of the surface of the incisors, cuspids or bicuspids this is considered tongue thrust (Hanson & Mason, 2003). Tongue thrust also occurs when the swallow is initiated by the anterior movement of the tongue against the central incisors thus exerting more than typical pressure against the teeth (Hanson & Mason, 2003; Logemann, 1998).

In 2013, Uma Dixit and Raghavendra Shetty conducted a study of 21 children with tongue thrust and 21 children without tongue thrust. The children without tongue thrust served as the control group. Measures of soft-tissue, dental, and skeletal characteristics of each group were compared. The authors found that an open bite was present in half of children with tongue thrust, while none of the children from the control group presented with an anterior open bite. The children without tongue thrust were found to have 1-2 mm of overjet and whereas an edge-to-edge bite was observed in more of the children with tongue thrust. An edge-to-edge bite is used to describe the relationship between the upper and lower incisors in which when closed the teeth of both jaws meet along the incisal edges. Additionally, none of the children in the control group presented with lisping, whereas 18 of the 21 children with tongue thrust exhibited lisps during speech.

Due to this abnormal relationship between the tongue and teeth which causes associated malocclusions, tongue thrust would be considered an oromyofunctional disorder (Hanson & Mason, 2003; Peng, et al. 2003).

In addition to research regarding the relationship of tongue thrust to dental malocclusions, recent research has demonstrated a possible link between tongue thrust behaviors and increase of risk for oropharyngeal dysphagia. In a 2011 Master's Thesis submitted by K. Holzer data of 387 individuals without identified pathologies who were part of a larger cross sectional swallowing study was analyzed. This study found that tongue thrust behaviors may be consistent with longer oropharyngeal transit time and therefore there is an increased risk of oropharyngeal dysphagia (Holzer, Fish, Lomen, Calley, Devine, Eakman, Loftin, Seikel, Sorenson, Peterson, 2011).

Evers, Seikel, Sorenson and Creelman (2013) examined 11 subjects with tongue thrust between the ages of 7 and 51. Electromyography (EMG) was used to examine masseter strength and oropharyngeal swallow time and the Iowa Oral Pressure Instrument (IOPI) was used to measure oral muscle strength. The results were compared to the norms gathered by Holzer et al. (2011). Signs of Oropharyngeal dysphagia were found to be present in these subjects with oromyofunctional disorder. A significant difference between masseter contraction was found between the norms gathered by Holzer et al. (2011) and EMG measurements collected on tongue thrusters by Evers et al. (2013) for right and left masseter contraction on 10 cc of water, and Triscuit cracker and for left masseter only on ½ tsp. pudding, 1 ½ tsp. pudding. While not found to be significant right masseter contractions for ½ tsp. pudding, 1 ½ tsp. pudding were decreased compared to norms. Evers et al. did not find significant differences in IOPI force for

masseter, lip, tongue tip or dorsum in the 11 tongue thrusters in this study when compared to norms. However, Evers et al. found these subjects to have nominally lower oral strength than predicted by the norms collected by Holzer et al. (2011), and the authors attribute this to the great variability in the normative data for these measures (Ever et al., 2013).

Evers et al. also compared oralpharyngeal transit time between the 11 subjects in this study with tongue thrust and the norms reported by Holzer (2011). Evers et al. found that those with tongue thrust had difficulty completing deglutition of the Triscuit cracker bolus. This study did find an increase in oralpharyngeal transit time 1/2 teaspoon pudding, 1 1/2 teaspoon pudding, and 10cc water for those with tongue thrust than the norms (Evers, et al., 2013).

There has been some debate in the prevalence of tongue thrust. We know from normal development that all babies are tongue thrusters at birth. According to Hanson and Mason (2003) approximately half of first grade children thrust their tongues, and by adolescence and adulthood that prevalence decreases to approximately 30% of individuals exhibiting tongue thrust.

Current research indicates that a multiple causation theory best explains the etiology of tongue thrust. The individual's basic anatomy will greatly impact habitual resting posture that in turn will impact the retention of tongue thrust. In relation to habitual resting posture, a low anterior resting posture can contribute to the retention of a tongue thrust after infancy (Hanson & Mason, 2003). Mouth breathing, which can be caused by allergies, enlarged adenoids, swollen nasal membranes and deviated septum can contribute to a low anterior resting posture (Hanson & Mason, 2003).

### *Treatment of Oromyofunctional Disorders*

As demonstrated, the fields of orthodontia and dentistry have included oromyofunctional disorders. Treatment methodologies have included surgical modifications (including partial glossectomies, tonsillectomies, and labial and lingual frenectomies), orthodontic modifications to reposition the teeth for more normal occlusions and mechanical restraints and reminders (frequently referred to as "cribs") (Hanson, 1976). In addition to these physical alterations and appliances speech therapy and oromyofunctioanl therapy have also been used to treat oromyofunctional disorders (ASHA, 2004; Hanson, 1976).

Rampp and Pannbacker's 1978 review of literature found that treatment of tongue thrust is indicated in a number of situations. Treatment of tongue thrust is recommended when the tongue thrust is associated with malocclusion after puberty, when speech is affected by the tongue thrust, or when facial grimacing is present concomitant with the tongue thrust (Rammp & Pannbacker, 1978).

Ehrlich (1973), reminds us that there must be "flexibility and adaption for individual needs" (pg. 89) when working with patients with tongue thrust. The treatment of oromyofunctional disorders generally targets the development of oral habits that support correct swallow. While there are a variety of programs available the sequence and goals of the programs are frequently very much the same. In general, therapy sessions should follow a similar outline: review of previous material, presentation of new procedures, explanation of any home programming (Ehrlich, 1973). The initial phase of most tongue thrust treatment programs includes establishment of new oral motor patterns (Buchanan, 2010; Hanson & Mason, 2003; Pierce, 1993). Once new oral motor patterns

are introduced the patient learns to strengthen and gain control over the correct swallow, then these newly learned habits become automatic through home programming exercises provided during therapy (Buchanan, 2010; Ehrlich, 1973; Hanson & Mason, 2003).

The first step in establishing new oral motor patterns is to bring about the ability of the patient to locate the correct resting posture of the tongue with the tongue tip resting against the alveolar ridge behind the upper incisors (Goldberger, 1976; Hanson & Mason, 2003; Pierce, 1993). The target area is frequently referred to as "the spot." Following the establishment of locating the spot, patients often proceed to holding small pieces of food, or other tiny items in place on the spot for increasingly extending periods of time (Goldberger, 1976; Hanson & Mason, 2003; Pierce, 1993). The next stage in most tongue thrust treatment programs is to begin working on the swallow with a focus on increasing muscular control of a correct swallow (Hanson & Mason, 2003). Exercises such as "dishing" the tongue to hold water or food, sealing the tongue against the hard palate may also be employed to increase the patient's ability to manage fluids and solids and propel them posteriorly. Home programming is often a component of tongue thrust correction therapy, with patients being given specific exercises to do at home as therapy progresses (Goldberger, 1976; Hanson & Mason, 2003; Pierce, 1993).

***Treatment Efficacy***

Treatment of oromyofunctional disorders has been an area of much debate in the field of speech-language pathology. During the 1970s the American Speech and Hearing Association, the American Dental Association and the American Association of Orthodontists each adopted policy statements that advised against oral myofunctional therapy until such time when research evidence of its efficacy was available (Hanson &

Mason, 2003). The reaction was a result of practices and claims by poorly trained people who had administered therapy that was ineffective (Hanson & Mason, 2003). A 1980 study of 35 typical children and 21 children with frontal lisping and anterior tongue thrust during swallow examined linguadental pressures in both groups using a lingual strength apparatus (Dworkin & Culatta, 1980). The results indicated that children with anterior tongue thrust did not exhibit stronger protrusive tongue forces than typical children, which was in contrast to previous data collected by Dworkin in 1978 and 1980 (Dworkin & Culatta, 1980). The authors concluded that given the tongue strengthening exercises would not be beneficial to correct tongue thrust since this study yielded no significant difference in tongue protrusion forces in children with and without tongue thrust (Dworkin & Culatta, 1980).

Weinberger (1973) presented data collected on 17 students who received tongue thrust therapy during the 1971-1972 school year at Canyon Independent School District. Students ranged in grade from kindergarten to seventh grade. The students were accepted throughout the school year; therefore each was at a different stage in therapy when the study concluded. Given that students were accepted throughout the year, number of participating students receiving therapy ranged from seventeen to twenty-four as new students were added. Weinberger found that of the students that received services, one student exhibited regression due to lack of medical attention. Fourteen students corrected their swallow, while others were still in the process of therapy at the time of publication (Weinberger, 1973).

A 1981 study conducted by Christensen and Hanson examined whether utilizing oral myofunctional services prior to articulation therapy was an effective course of

treatment. The study consisted of 10 subjects in kindergarten, with a mean age of 6.2 years, who had previously been diagnosed as having severe anterior tongue thrust accompanied by visible and audible frontal lisp. The subjects were divided into two groups, each receiving 14 weeks of treatment. The test group was given oromyofunctional therapy for the initial 6 weeks of the study followed by alternating articulation and oromyofunctional therapy for the remainder of the study. The control group received only articulation therapy. The results of this study revealed that while both the test and the control groups made similar progress in remediation of articulation errors, only the test group exhibited decreased tongue thrusting behaviors as well.

From the case files of Barrett, Harden and Rydell randomly selected 50 subjects between the ages of 13 and 32 who had received tongue thrust therapy from Barrett at least five years prior to their study (Harden & Rydell, 1984). A control group of 30 subjects was also randomly selected. The control group was comprised of individuals who had been diagnosed with a mean age similar to that of the test group, but who had previously declined therapy. Swallowing behaviors with parted lips, masseter contraction during swallow, movement of the mandible during swallow, and configuration of the mentalis was examined or observed in both groups. Conscious and habitual swallows were both observed. The researchers documented the type of tongue thrust based on the scale developed by Barrett and Hanson. Retention of a correct swallow pattern in those who had previously received treatment included: contraction of the masseter muscles during swallow, absence of tension in the mentalis muscle and lips during swallow and absence of movement of the mandible during swallow. The study revealed that the majority of subjects retained the correct swallowing behaviors at least five years after

treatment by Barrett, while few subjects in the control group exhibited appropriate swallow behaviors. After five years, none of the treatment group exhibited what the authors referred to as a type 2 tongue thrust, which is characterized by the tongue protruding past the cutting edge of either the upper or the lower incisors, whereas 96.6% of the control group did, in fact, exhibit a type 2 tongue thrust.

Andrianopoulos and Hanson (1987) conducted examinations of two groups (a treatment group and a non-treatment group) of subjects all of whom had been classified as having class II, division 1 malocclusions prior to orthodontic treatment by their orthodontists. The treatment group consisted of 17 subjects who had completed treatment for tongue thrust at the University of Utah. The non-treatment group of 17 subjects, who had not participated in any treatment of tongue thrust, had received orthodontic treatment with both fixed appliances and retainers. These subjects had not worn upper retainers for at least one year. The researchers found that 17.6% of the treatment group and 70.6% of the non-treatment group were tongue thrusting at the time of the study. Examination of the mean relapse of overjet was found to be greater in the non-treatment group (Andrianopoulos & Hanson, 1987).

In 1989 ASHA reviewed their policies and an ad hoc committee was formed. Revisions to the position paper regarding oral myofunctional therapy were made in light of the new evidence (Hanson & Mason, 2003). Current policy holds that oral myofunctional disorders during swallow can be reliably identified and co-occur with speech misarticulations. Furthermore, ASHA's position statement (1993) indicates that published research supports the effectiveness of oral myofunctional therapy and that this therapy falls under the purview of speech-language pathology (ASHA, 1993).

Ferreira, Mangill, Sassi, Fortunato-Tavares, Limongi, and Furqui, de Andrade published a critical review of the literature regarding the physiology and effects of exercises used in the treatment of oral myofunctional disorders (2011). The authors examined 38 articles for which full text was available following the Cochrane Handbook research method. The overall findings by these authors indicated that the available experimental studies most frequently included frequency and duration of therapy, but lacked information regarding the number of repetitions of each exercise were performed during the therapy sessions. The authors found that there is a paucity of clinical trials in the field of speech-language pathology, and existing studies included few participants. They point out the bulk of available evidence points to the overall efficacy of therapeutic programs, but there is a lack of evidence regarding individual exercises and appropriate frequency of those exercises (Ferreira, et al., 2011).

The purpose of this study was to replicate and add to the evidence regarding the efficacy of oromyofunctional exercises, specifically the slurp-swallow, provided by the study conducted by Alixandrea Buchanan (2007) . The purpose of Buchanan's study was to determine if 10 treatment sessions utilizing the slurp-swallow would increase tongue tip and dorsum strength. The study looked at 4 children with tongue thrusting behaviors that were between the ages of 8 and 12. The investigation utilized a quasi-multiple baseline across behaviors model, replicated across subjects. Tongue strength was measured using the Iowa Oral Performance Instrument (Breakthrough Inc., Oakdale, IA; Model 1.5) and served as the dependent variable. Lip strength and sustained vowel /a/ served as controls. During each of the 10 therapy sessions tongue tip strength was measured, with baseline measures having been collected prior to initiation of therapy.

Each subject completed 50 slurp-swallow exercises during each of the therapy sessions. The research hypothesis of the Buchanan study was supported for three out of the four participants. Buchanan cited lack of motivation as a factor for the decrease in performance across both the controls and the dependent variable for the subject that did not show improvement. Her findings indicated that the slurp-swallow was effective in increasing lingual force.

***IOPI***

The Iowa Oral Performance Instrument (IOPI) is used to measure lingual force. The instrument works by having a person press an air filled bulb as hard as he or she can against the roof of the mouth with the tongue. The IOPI displays the maximum force in kilopascals (Hewitt et al., 2008). According to Youmans, Youmans, and Stierwalt (2009) the IOPI is a reliable and valid instrument that can be used to objectively establish measures of tongue strength. Ono, Hori, Nokubi cite the usefulness of the IOPI in assessment of tongue pressure, noting that while it is not an effective tool for evaluating natural mastication and swallowing, it can provide information about the functional movement of the tongue during swallow (Ono, Hori, Nokubi, 2004). Furthermore, they state that strength of the tongue-palate contact can be measured over time and at any position (Ono et al., 2004). In 2012 Clark and Solomon reported findings regarding age and sex differences in orofacial structures. Tongue function, which includes strength, is necessary to successful mastication and deglutition. Clark and Solomon compared lingual, labial and buccal strength measurements across age and gender in 88 men and 83 women. They concluded that sex differences were noted in cheek and lip strength but not

tongue strength measurements with men having greater degrees of lip and cheek strength (Clark & Solomon, 2012).

***Idaho State University Tongue Thrust Protocol***

For the purpose of this study, the Idaho State University Tongue Thrust Protocol (ISUTTP) was employed to assess the presence of tongue thrust. This protocol calls for a detailed case history which includes feeding history, family history of swallowing, history of negative habits such as digit sucking, prolonged use of bottle or pacifier, mouth breathing, medical and anatomical history and neurophysiological issues. After the case history is collected the subject is observed at rest for facial tone and symmetry, as well as nose verses mouth breathing. The relationship between the lips and the teeth are observed, by determining how much of the upper teeth are covered by the upper lip when the mouth opens. The resting posture of the tongue is noted followed by the lip movement during dry swallow and determination of perceived macroglossia. After these observations are made the relationship between upper and lower teeth is determined and the teeth are observed for signs of open bite or closed bite. The lips are observed next. The clinician looks for signs of chapping, low tone ("fat" lower lip), and over jet The palate is examined observing, noting if there is the presence of a high vault to the hard palate, adequate and functional soft palate with no sign of submucus cleft. The tongue is examined to determine that it is of adequate size (no signs of micro- or macroglossia), determination that the frenulum is of adequate length, and note resting posture. The next portion of the ISUTTP requires observation of respiration. A determination of adequate respiratory support is completed by observation, having the subject count to 30, and as well as through the use of manometer. Following the observation and examination of the

oral mechanism the subject is asked to swallow two different boluses (water and a cookie/cracker). Each bolus type is performed 3 times and observations are made regarding masseter contraction, lip tension, presence of tongue thrust as well as bolus formation for the cracker/cookie.

Treatment of tongue thrust utilizing orofacial myofunctional therapy has been well documented in the literature. There remains little evidence regarding the efficacy of specific exercises. This study sought to add to the evidence base regarding the efficacy of the "slurp-swallow" exercise for the treatment of tongue thrust. This study replicated and expanded on the study conducted by Buchanan in 2007, by including both adults and a child as subjects.

## Chapter II-Methodology

### *Method*

The purpose of this study was to determine if 10 treatment sessions utilizing the slurp-swallow exercise would increase tongue tip and tongue dorsum strength. The current study replicated the study conducted by Alixandrea Buchanan (2007), but included subjects from a wider age range in order to add to the available evidence regarding specific oromyofunctional exercises for the treatment of tongue thrust.

### *Participants*

The sample consisted of 3 individuals from Potter County, Pennsylvania and one subject from Colorado. They included 1 male child age 7 years 8 months and 3 adult females ages 33 years 2 months, 33 years 8 months, 33 years 6 months. The mean age of the total sample was 27 years 0 months, the mean age for adults only was 33 years 5 months. Three of the four subjects identified themselves as Caucasian and the fourth identified herself as being from Asian-American decent. Each subject demonstrated tongue thrust during swallow. The participants were pre-identified as having tongue thrust by licensed speech-language pathologists or orthodontists. To be included in the study the individuals needed to demonstrate visible tongue protrusion during swallow and at least one of the following: excessive use of labial musculature, spillage during water and food swallows, lack of masseter contraction, or significant food residue in the oral cavity after swallowing. The above are all indications of tongue thrust. Subject 1 (male age 7:8) demonstrated visible tongue protrusion, spillage during all swallows and significant residue. Subject 2 (female, age 33:2) exhibited tongue protrusion, spillage

during swallows and lack of palpable masseter contraction. Subject 3 (female, age 33:8) exhibited tongue protrusion, spillage of food and liquids on all swallows and excessive labial musculature. Subject 4 (female, age 33:6) exhibited the least amount of tongue protrusion, but it was still visible and spillage was noted on liquid swallows. In addition, the individuals were not considered eligible for the study if they had received prior treatment for tongue thrust or had received any special education services other than speech and language services.

***Experimental Design***

The current study utilized a quasi-multiple baseline across behaviors model which was replicated across all subjects. The independent variable was the participation in ten treatment sessions, conducted on consecutive weekdays, utilizing the slurp-swallow exercise. The dependent variables were measurements of tongue tip and dorsum strength across baseline and treatment phases. These measurements were used to determine treatment effects. Control variables consisted of measurements of lip strength and the sustained vowel /a/ as it has been determined that it is unlikely that the slurp-swallow, which targets tongue strength, will have an effect on these measurements. Baseline measurement of both independent and control variables was established in the initial session prior to engaging in the slurp-swallow exercise. Measurement of all variables was recorded at the beginning of each therapy session. Participants then practiced the slurp-swallow exercise 50 times during each of the 10 treatment sessions, with therapist feedback on performance. Following completion of the 50 repetitions of the exercise the tongue tip and dorsum strength measurements were repeated. The data collected at each session for each measure and were plotted on line graphs. Statistical significance for

each subject and each variable were determined using the 2-standard deviation band method (Nourbakhsh & Ottenbacher, 1994). For each measure the average of 3 trials were graphed for each individual across each session. The standard deviation of the baseline data for each individual measure was calculated from the data collected during each of the three baseline trials. Next, lines corresponding to 2 standard deviations above and 2 standard deviations below the baseline mean were drawn on each corresponding graph. If more than two treatment points fell outside this band the treatment effect was considered to be significant, because there is only a 5/100 chance of this occurring (Nourbakhsh & Ottenbacher, 1994).

***Instrumentation***

The Iowa Oral Performance Instrument (Breakthrough Inc., Oakdale, IA; Model 1.5) was used to measure tongue strength. The Iowa Oral Performance Instrument (IOPI) is digital voltmeter that measures pressures in Pascals (kPa) exerted on a small bulb. The bulb of this handheld device was placed on the tongue and the subject pressed it against the hard palate with the tongue. The subject was instructed to use only the tongue and was monitored to ensure that the jaw was not engaged during the measurement.

***Procedures***

A packet containing a description of the research procedures, informed consent letter and assent letter was distributed to the participants or in the case of children to the participants' parents or guardians prior to the initiation of this study. Signed informed consent letters were collected prior to the first meeting with the subjects.

The researcher discussed the information contained in the consent and assent forms and fielded questions from the parents/guardians and the participants during the

initial research session. A screening procedure derived from the Idaho State University Tongue Thrust Protocol was used to verify presence of tongue thrust behaviors. This protocol consists of observation of swallow to confirm observed tongue protrusion during swallow and at least one of the following: excessive labial musculature, spillage of food or liquid during, lack of masseter contraction or significant residue in mouth after swallow.

***Baseline***

*IOPI*

The subjects were familiarized with the IOPI following confirmation of tongue thrust behaviors. Familiarization occurred via an explanation of the device and its workings, followed by instruction and practice in the measurement procedure with a practice bulb not connected to the machine. Once the researcher had determined that the subject understood the measurement task by demonstrating the ability to press the bulb against the roof of the mouth when the bulb is placed on the tongue, the researcher then connected the tongue bulb to the IOPI. Measurements of the tongue tip were collected with the bulb placed on the anterior portion of the tongue, while measurements of the dorsum were collected with the bulb placed on the dorsum of the tongue. Each measurement was taken 3 times.

Control measures were then collected for baseline data. Lip strength and sustained vowel /a/ were chosen because it is presumed that tongue strengthening exercise, such as the slurp-swallow, would not affect them. They are however, sensitive to extraneous variables such as maturation. Lip strength was measured using the IOPI. The bulb was placed between the lips, ensuring that the teeth were not pressing on the bulb. The subject was instructed to press the bulb between the lips. This measurement

was collected over three trials. To measure sustained production of the vowel /a/ the subject was instructed to produce /a/ for as long as he or she could over three trials as well.

***Treatment***

As described in the baseline phase, independent and control variables were measured at each session prior to engaging in the treatment. Following the measurements the slurp-swallow exercise was correctly performed by the subject 50 times, with clinician feedback as needed to ensure correct practice of the exercise. The slurp-swallow was performed presented in the Swallow Right program (Pierce, 2002), and is outlined below:

1. Explain and help the subject find the correct tongue placement on the ridge behind the teeth referred to as the "spot."
2. Instruct the subject to hold his or her tongue on the "spot."
3. Instruct the subject to bite his or her molars together.
4. Instruct the subject to keep the molars together while smiling a wide, open-lip smile.
5. Instruct the subject to slurp.
6. Instruct the subject to swallow.

According to Pierce (2002) subjects should be instructed periodically to feel the backward motion of the tongue as it moves posteriorly prior to the swallow.

***Reliability***

*Inter-judge reliability*

Inter-judge reliability procedures were conducted by a speech-language pathologist who attended all sessions for one subject and independently recorded the measurements of the variables to determine consistency of the measurements. The scores

gathered by the researcher and the observing SLP were compared using the Pearson Product-Moment Correlation Coefficient. Using Microsoft Excel, the mean for 3 trials for each measurement collected by the researcher across all sessions for the subject were compared using the Pearson Product-Moment Correlation Coefficient to the mean across 3 trials for each measurement collected by the SLP. A correlation coefficient (*r*) greater than or equal to +.70 was considered to have a very strong positive relationship between the two sets of scores.

When *r* was calculated for means of the control variable sustained vowel /a/ a correlation coefficient of -.39 was obtained, this indicates a moderate negative relationship. A correlation coefficient of +.58 was obtained for the second control variable of lip strength, indicating a strong positive relationship. The correlation coefficient for the dependent variables indicated very strong positive relationships between the means collected across 3 trials for each measurement by the researcher and the SLP. When *r* was calculated for tongue tip measurements taken at the beginning of each session the correlation coefficient was +.97, and for the measurements taken immediately following the exercises $r = +.71$. Comparison of dorsum strength measurements also indicates a very strong positive relationship between measurements collected by the researcher and those collected by the SLP, with $r = +.98$ for measurements taken at the beginning of each session and $r = +.95$ for measurements taken immediately following completion of exercises.

*Procedural Reliability*

A certified speech-language pathologist observed greater than 10% of selected sessions. Procedures outlined in the Methods section was provided in a checklist format to the observing SLP who marked a plus next to items that were completed as determined

in the Methods section. A procedural reliability score was be calculated by dividing the number of plus marks by the total number of items then multiplying that number by 100. Procedural reliability was calculated to be 92.19% indicating very strong procedural reliability.

***Materials***

The materials utilized in this study included:

Iowa Oral Performance Instrument (Breakthrough Inc., Oakdale, IA; Model 1.5).

Bolus materials including prepared packaged pudding, water and Triscuit crackers

Large Plastic oral syringe to accurately measure boluses.

HP laptop computer

Microsoft Excel

## Chapter III-Results

The purpose of the current study was to add to the available evidence regarding the effectiveness of the slurp-swallow exercise by replicating the Buchanan (2007) study. This study expanded on the design of the Buchanan study by including adults as well as a child. The study sought to determine if block practice with 50 repetitions the slurp-swallow exercise during 10 researcher led treatment sessions would yield retention of increased measurements of both tongue tip and dorsum strength in individuals with tongue thrust. Baseline measures of tongue strength and control variables were obtained during the initial session prior to the initiation of treatment. Sustained vowel /a/ and lip strength served as control measures. All participants demonstrated increased superior lingual force and retained gains after 2-8 weeks with no treatment (see Table 1).

**Table 1-Dependant Variable Data**

| | Session | Tongue Tip Max Force (kPa) at Beginning of Sessions | Session | Tongue Tip Max Force (kPa) Immdiatley Following Practice of 50 Slurp-Swallows | Tongue Dorsum Max Force (kPa) at Beginning of Sessions | Session | Tongue Dorsum Max Force (kPa) Immdiatley Following Practice of 50 Slurp-Swallows |
|---|---|---|---|---|---|---|---|
| Subject 1 | Baseline | 10.00 | Session 1 | 13.00 | 16.00 | Session 1 | 22.00 |
| | Session 10 | 23.00 | Session 10 | 24.00 | 62.00 | Session 10 | 68.00 |
| | Retention | 20.00 | Retention | | 57.00 | Retention | |
| Subject 2 | Baseline | 19.00 | Baseline | 12.00 | 31.00 | Baseline | 35.00 |
| | Session 10 | 37.00 | Session 10 | 47.00 | 71.00 | Session 10 | 72.00 |
| | Retention | 33.00 | Retention | | 71.00 | Retention | |
| Subject 3 | Baseline | 13.00 | Baseline | 18.00 | 43.00 | Baseline | 41.00 |
| | Session 10 | 29.00 | Session 10 | 22.00 | 56.00 | Session 10 | 62.00 |
| | Retention | 28.00 | Retention | | 56.00 | Retention | |
| Subject 4 | Baseline | 34.00 | Baseline | 28.00 | 39.00 | Baseline | 40.00 |
| | Session 10 | 37.00 | Session 10 | 67.00 | 70.00 | Session 10 | 72.00 |
| | Retention | 52.00 | Retention | | 71.00 | Retention | 72.00 |

***Subject 1***

Subject 1 was a male age 7 years 8 months. He attended 10 treatment sessions across 10 consecutive weekdays at Northern Potter Children's School. Case history indicated a significant history of articulation delays and digit sucking that persisted. Subject presented with anterior open bite and class II malocclusion. The Idaho State University Tongue Thrust Protocol confirmed the presence of tongue thrust. The subject was unable to retain water in the oral cavity without sealing the lips and significant spillage was noted when labial seal was not used to aide retention of the bolus upon swallow. Significant debris remained on the tongue and in the sulci after swallow, and multiple swallows per bolus were observed. He presented with open mouth posture at rest, lack of palpable masseter contraction upon swallow. The subject was not informed as to which measures were being targeted in treatment. Subject 1 was compliant and motivated throughout the treatment sessions. He needed very little prompting to complete the exercises. Verbal praise along with feedback of performance of the exercises was given. He was given water to maintain oral moisture to make exercises easier. Subject 1 stopped frequently for drinks, thus effectively breaking the 50 repetitions into groups of 10-20. Though the researcher encouraged the subject to return quickly to task, the subject would pause to ask questions or make comments before returning to the task.

Baseline measures were collected across three trials for each variable with minor variability between each trial. Table 2 illustrates the measurements for tongue tip forces across the baseline and treatment sessions, measurements were taken before practice of the slurp-swallow exercise and immediately after completion of the 50 repetitions. Table

3 illustrates the measurements for the dorsum force across the baseline and treatment sessions.

**Table 2- Tongue tip strength measurements in kPa**

*Tongue tip strength measurements in kPa with baseline, and means taken at the beginning of the session and means immediately following practice 50 repetitions of the slurp-swallow exercise for subject 1*

| *Tongue Tip Force in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials* | | | | | *Tongue Tip Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Mean Across 3 Trials* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Session* | *Trial 1* | *Trial 2* | *Trial 3* | *Mean Force* | *Session* | *Trial 1* | *Trial 2* | *Trial 3* | *Mean Force* |
| Baseline | 10.00 | 10.00 | 8.00 | 9.33 | Session 1 | 12.00 | 13.00 | 11.00 | 12.00 |
| Session 2 | 8.00 | 11.00 | 10.00 | 9.67 | Session 2 | 13.00 | 13.00 | 12.00 | 12.67 |
| Session 3 | 12.00 | 12.00 | 11.00 | 11.67 | Session 3 | 14.00 | 12.00 | 15.00 | 13.67 |
| Session 4 | 12.00 | 13.00 | 12.00 | 12.33 | Session 4 | 14.00 | 15.00 | 14.00 | 14.33 |
| Session 5 | 14.00 | 12.00 | 12.00 | 12.67 | Session 5 | 13.00 | 15.00 | 13.00 | 13.67 |
| Session 6 | 17.00 | 18.00 | 16.00 | 17.00 | Session 6 | 15.00 | 17.00 | 17.00 | 16.33 |
| Session 7 | 16.00 | 17.00 | 19.00 | 17.33 | Session 7 | 20.00 | 19.00 | 21.00 | 20.00 |
| Session 8 | 22.00 | 19.00 | 21.00 | 20.67 | Session 8 | 20.00 | 17.00 | 19.00 | 18.67 |
| Session 9 | 22.00 | 19.00 | 21.00 | 20.67 | Session 9 | 24.00 | 24.00 | 23.00 | 23.67 |
| Session 10 | 23.00 | 22.00 | 21.00 | 22.00 | Session 10 | 24.00 | 22.00 | 24.00 | 23.33 |
| Retention | 19.00 | 20.00 | 20.00 | 19.67 | | | | | |

**Table 3-** ***Dorsum strength measurements in kPa***

*Dorsum strength measurements in kPa with baseline, and means taken at the beginning of the session and means immediately following practice 50 repetitions of the slurp-swallow exercise for subject 1*

| *Tongue Dorsum Force in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials* | | | | | *Tongue Dorsum Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Mean Across 3 Trials* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Session* | *Trial 1* | *Trial 2* | *Trial 3* | *Mean Force* | *Session* | *Trial 1* | *Trial 2* | *Trial 3* | *Mean Force* |
| Baseline | 16.00 | 15.00 | 14.00 | 15.00 | Session 1 | 18.00 | 20.00 | 22.00 | 20.00 |
| Session 2 | 16.00 | 14.00 | 14.00 | 14.67 | Session 2 | 25.00 | 20.00 | 23.00 | 22.67 |
| Session 3 | 17.00 | 18.00 | 20.00 | 18.33 | Session 3 | 25.00 | 25.00 | 23.00 | 24.33 |
| Session 4 | 24.00 | 23.00 | 26.00 | 24.33 | Session 4 | 33.00 | 30.00 | 31.00 | 31.33 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Session 5 | 37.00 | 37.00 | 39.00 | 37.67 | Session 5 | 42.00 | 41.00 | 43.00 | 42.00 |
| Session 6 | 44.00 | 43.00 | 40.00 | 42.33 | Session 6 | 45.00 | 47.00 | 49.00 | 47.00 |
| Session 7 | 48.00 | 48.00 | 50.00 | 48.67 | Session 7 | 56.00 | 58.00 | 57.00 | 57.00 |
| Session 8 | 50.00 | 57.00 | 55.00 | 54.00 | Session 8 | 60.00 | 60.00 | 61.00 | 60.33 |
| Session 9 | 59.00 | 58.00 | 58.00 | 58.33 | Session 9 | 60.00 | 58.00 | 63.00 | 60.33 |
| Session 10 | 58.00 | 62.00 | 60.00 | 60.00 | Session 10 | 66.00 | 67.00 | 68.00 | 67.00 |
| Retention | 56.00 | 54.00 | 57.00 | 55.67 | | | | | |

Tables 4 and 5 below represent the maximum lingual force exerted across the three trials for Tongue Tip strength and Dorsum strength respectively.

**Table 4**- ***Maximum tongue tip force***

*Maximum tongue tip force obtained at the beginning of each session and then again immediately following practice of 50 slurp-swallow exercises for subject 1*

| *Tongue Tip Force in Pascals (kPa) at the Beginning of Each Session-Maximum Achieved Across 3 Trials* | |
|---|---|
| *Session* | *Max. Force* |
| Baseline | 10.00 |
| Session 2 | 11.00 |
| Session 3 | 12.00 |
| Session 4 | 13.00 |
| Session 5 | 14.00 |
| Session 6 | 18.00 |
| Session 7 | 19.00 |
| Session 8 | 22.00 |
| Session 9 | 22.00 |
| Session 10 | 23.00 |
| Retention | 20.00 |

| *Tongue Tip Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Maximum Achieved Across 3 Trials* | |
|---|---|
| *Session* | *Max. Force* |
| Session 1 | 13.00 |
| Session 2 | 13.00 |
| Session 3 | 15.00 |
| Session 4 | 15.00 |
| Session 5 | 15.00 |
| Session 6 | 17.00 |
| Session 7 | 21.00 |
| Session 8 | 20.00 |
| Session 9 | 24.00 |
| Session 10 | 24.00 |

**Table 5**- ***Maximum dorsum force***

*Maximum dorsum force obtained at the beginning of each sessions and then again immediately following practice of 50 slurp-swallow exercises for subject 1*

| *Tongue Dorsum Force in Pascals (kPa) at the Beginning of Each Session-Maximum Achieved Across 3 Trials* | |
|---|---|
| *Session* | *Max. Force* |
| Baseline | 16.00 |
| Session 2 | 16.00 |
| Session 3 | 20.00 |
| Session 4 | 26.00 |
| Session 5 | 39.00 |
| Session 6 | 44.00 |
| Session 7 | 50.00 |
| Session 8 | 57.00 |
| Session 9 | 59.00 |
| Session 10 | 62.00 |
| Retention | 57.00 |

| *Tongue Dorsum Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Maximum Achieved Across 3 Trials* | |
|---|---|
| *Session* | *Max. Force* |
| Session 1 | 22.00 |
| Session 2 | 25.00 |
| Session 3 | 25.00 |
| Session 4 | 33.00 |
| Session 5 | 43.00 |
| Session 6 | 49.00 |
| Session 7 | 58.00 |
| Session 8 | 61.00 |
| Session 9 | 63.00 |
| Session 10 | 68.00 |

Subject 1 demonstrated increases in both measures of superior lingual strength. Figures 1 and 2 (below) illustrate these increases with scores falling along a trend line with an increasing slope for both tongue tip strength measures taken at the beginning of sessions and those taken immediately after treatment each session. The 2 Standard Deviation Band Method (Nourbakshs & Ottenbacher, 1994) was used to determine if the gains noted were statistically significant. As illustrated in the Figures below, more than 2 data points lie outside of the +/- 2 SD range, indicating the changes were significant.

**Figure 1- Tongue Tip Force in Pascals (kPa) at the Beginning of Each Session**

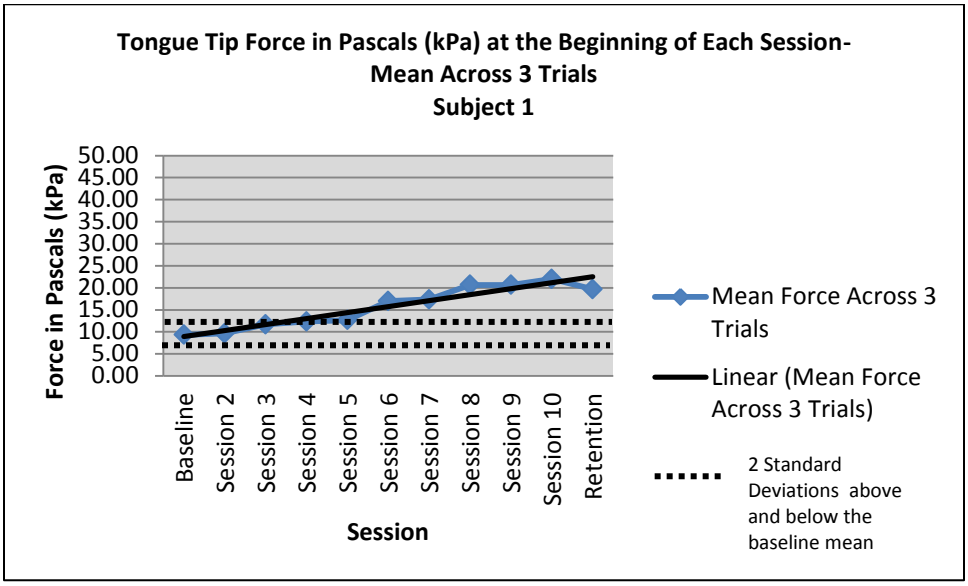
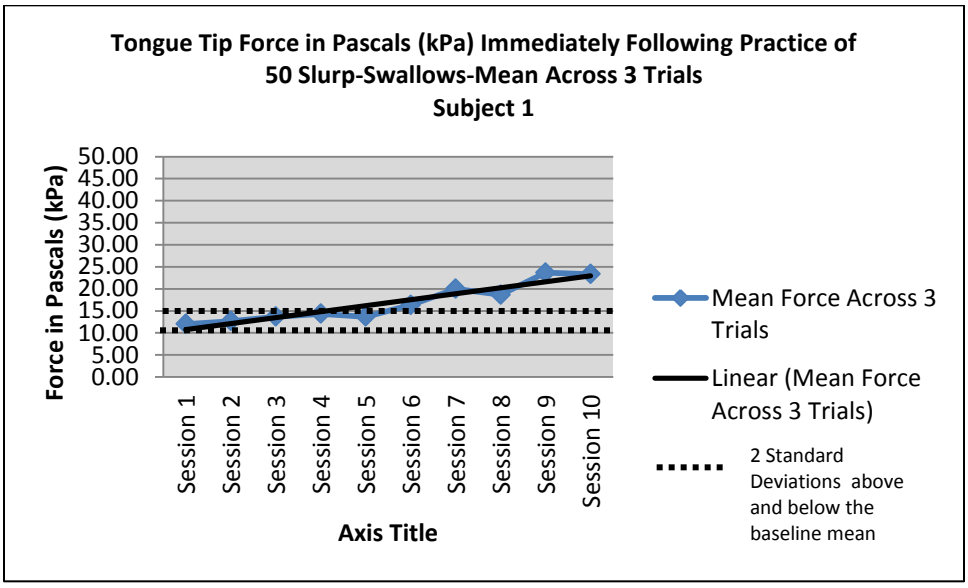



**Figure 2- Tongue Tip Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows**




Dorsum strength measures also increased. Figures 3 and 4 (below) display dorsum measurements across baseline and treatment sessions. Again, the increases observed are significant given that more than 2 data points lie outside of the +/- 2 SD range.

**Figure 3- Tongue Dorsum Force in Pascals (kPa) at the Beginning of Each Session**

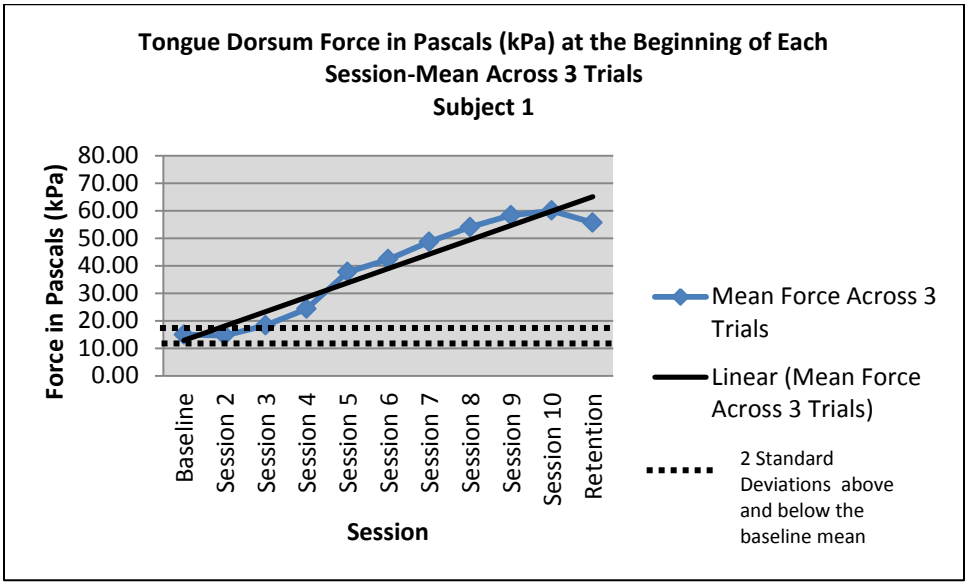
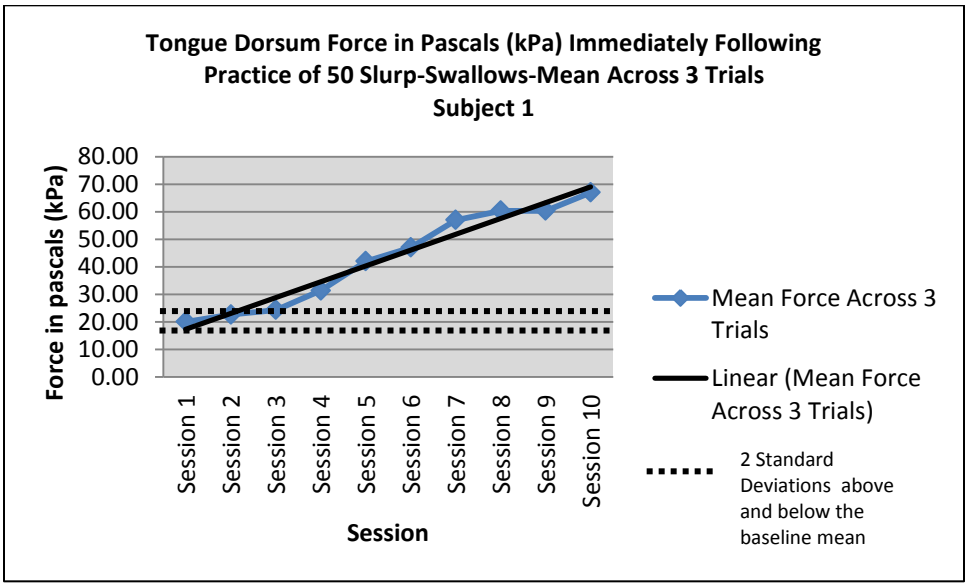



**Figure 4- Tongue Dorsum Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows**




Analysis of both lip strength and sustained vowel /a/ measurements, which served as controls and were collected prior to treatment each session, concluded that these measures remained relatively stable across the baseline and treatment sessions. Figure 5 illustrates this with a level trend line for lip strength. The relatively flat trend line for

sustained vowel /a/ can be seen in Figure 6. The data points for each of these measures fall within the +/- 2 SD band indicating to significant change.

**Figure 5- Lip Strength in Pascals (kPa) at the Beginning of Each Session**

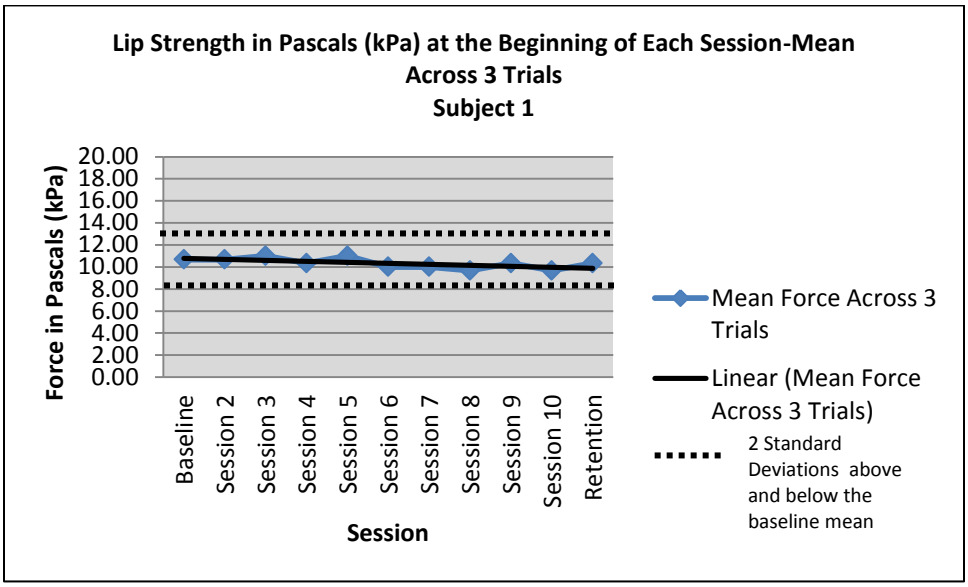
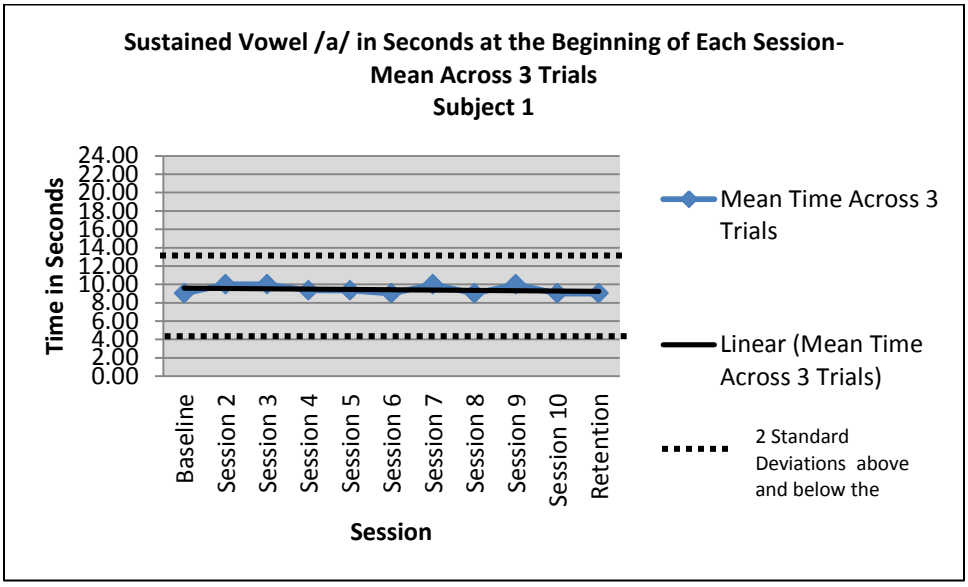



**Figure 6- Sustained Vowel /a/**




Analysis of the increased measurements in superior lingual force paired with the relatively stable measurements for the control variables suggests that participation in

treatment with practice of the slurp-swallow exercise is responsible for increases in superior lingual force rather than extraneous factors such as maturation.

*Summary:*

Subject 1 was a 7 year 5 month old male who presented with moderate to severe tongue thrust with type II malocclusion, anterior open bite and open mouth posture at rest. The measurements for sustained vowel /a/ and lip force remained stable as illustrated by the linear trend line and all data points fell within the +/- 2 SD band indicating no significant change. Tongue tip and dorsum strength measurements were taken at the beginning of each session and immediately following the completion of 50 repetitions of the slur-swallow exercise each session. Superior lingual force increased throughout the treatment period. Linear trend lines lie along a positive path indicating increases and more than two data points for each measure lie outside of the +/- 2 SD band suggesting that the increase was indeed significant. Measures of each variable were collected exactly two weeks after the $10^{th}$ treatment session with no treatment provided during that time. The subject demonstrated retention of increased superior lingual force and coordination when retention data was compared to baseline measures for both tongue tip force and dorsum strength. Control variables sustained vowel and lip strength continued to remain stable from baseline measurements to retention measurements.

***Subject 2***

Subject 2 was a female age 33 years and 2 months. She was diagnosed with tongue thrust by an orthodontist and completed 2 years of orthodontic treatment including braces to correct a type II malocclusion. The subject reports that her family physician referred her to the orthodontist for treatment due to chronic migraines, which they

hypothesized, were caused by TMJ syndrome and poor dental alignment and pressure. Following the braces the subject continues to be required to wear a retainer at all times with the only exception being during meals. She had not received any treatment to correct her swallow and was never recommended for oromyofunctional therapy. Subject 2 presented with closed mouth breathing, and closed relaxed lips at rest. Case history was positive for moderate to severe seasonal allergies, with no reported history of digit sucking, pacifier use or prolonged bottle use. The Idaho State University Tongue Thrust Protocol was conducted prior to treatment sessions. The subject was able to form a bolus of food with little or no debris retained after swallow. Observation of the swallow with lips open revealed that the tongue made contact against the interior incisors upon swallow for both liquid and solid boluses and was visible between the teeth during the swallow. With lip open the subject was unable to maintain neither the liquid bolus nor the pudding bolus and liquid and food material seeped out between the teeth as the tongue pressed forward.

Subject 2 attended 10 treatment sessions over 10 consecutive days. During treatment the subject reported to the researcher that the exercises became "easier" as sessions progressed. Water was provided to maintain oral moisture. The subject was allowed to pause for water at any point. As treatments progressed it was observed that water "breaks" were less frequently needed. Time to complete the 50 repetitions of the slurp-swallow decreased from 18 minutes during the first session to 7 minutes during the $10^{th}$ session. She reported that between treatment sessions her lingual resting posture was more superior with her tongue resting more frequently on the hard palate rather than the floor of the oral cavity. By her reports subject 2 demonstrated heightened awareness of

the sensations she felt during and between treatment sessions when compared to subject 1. She expressed a high level of motivation to correct her tongue thrust so that the results obtained by the orthodontic work could be maintained. When asked about the frequency and intensity of the migraines she had prior to braces, the subject noted that they were less frequent since her bite was corrected. She stated that of more importance to her than the frequency was the significant decrease in the intensity of the headaches. She expressed a desire to maintain this decrease in frequency and intensity by maintaining the position of her dentition.

Baseline measures were collected across three trials for each variable with very little variability between each trial. An average baseline of 31.00 kPa for dorsum and 32.33 kPa for tongue tip were achieved. Tables 6 and 7 below illustrate the measures for superior lingual force as measured through tongue tip force and dorsum force across the baseline and treatment sessions.

**Table 6-** ***Tongue tip strength measurements in kPa***

*Tongue tip strength measurements in kPa with baseline, and means taken at the beginning of the session and means immediately following practice 50 repetitions of the slurp-swallow exercise for subject 2*

| *Tongue Tip Force in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials* | | | | | *Tongue Tip Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Mean Across 3 Trials* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Session* | *Trial 1* | *Trial 2* | *Trial 3* | *Mean Force* | *Session* | *Trial 1* | *Trial 2* | *Trial 3* | *Mean Force* |
| Baseline | 18.00 | 19.00 | 18.00 | 18.33 | Session 1 | 11.00 | 12.00 | 12.00 | 11.67 |
| Session 2 | 18.00 | 19.00 | 19.00 | 18.67 | Session 2 | 13.00 | 12.00 | 14.00 | 13.00 |
| Session 3 | 19.00 | 19.00 | 17.00 | 18.33 | Session 3 | 18.00 | 20.00 | 21.00 | 19.67 |
| Session 4 | 19.00 | 20.00 | 18.00 | 19.00 | Session 4 | 21.00 | 21.00 | 25.00 | 22.33 |
| Session 5 | 22.00 | 24.00 | 20.00 | 22.00 | Session 5 | 27.00 | 28.00 | 26.00 | 27.00 |
| Session 6 | 24.00 | 25.00 | 19.00 | 22.67 | Session 6 | 28.00 | 28.00 | 30.00 | 28.67 |
| Session 7 | 27.00 | 26.00 | 29.00 | 27.33 | Session 7 | 31.00 | 35.00 | 37.00 | 34.33 |
| Session 8 | 30.00 | 32.00 | 35.00 | 32.33 | Session 8 | 37.00 | 38.00 | 39.00 | 38.00 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Session 9 | 35.00 | 37.00 | 36.00 | 36.00 | Session 9 | 41.00 | 39.00 | 42.00 | 40.67 |
| Session 10 | 34.00 | 37.00 | 36.00 | 35.67 | Session 10 | 44.00 | 43.00 | 47.00 | 44.67 |
| Retention | 32.00 | 33.00 | 31.00 | 32.00 | | | | | |

**Table 7-** ***Dorsum strength measurements in kPa***

*Dorsum strength measurements in kPa with baseline, and means taken at the beginning of the session and means immediately following practice 50 repetitions of the slurp-swallow exercise for subject 2*

| *Tongue Dorsum Force in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials* | | | | | *Tongue Dorsum Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Mean Across 3 Trials* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Session* | *Trial 1* | *Trial 2* | *Trial 3* | *Mean Force* | *Session* | *Trial 1* | *Trial 2* | *Trial 3* | *Mean Force* |
| Baseline | 30.00 | 32.00 | 31.00 | 31.00 | Session 1 | 35.00 | 31.00 | 31.00 | 32.33 |
| Session 2 | 31.00 | 33.00 | 37.00 | 33.67 | Session 2 | 38.00 | 39.00 | 40.00 | 39.00 |
| Session 3 | 38.00 | 30.00 | 37.00 | 35.00 | Session 3 | 42.00 | 40.00 | 44.00 | 42.00 |
| Session 4 | 42.00 | 44.00 | 47.00 | 44.33 | Session 4 | 50.00 | 51.00 | 51.00 | 50.67 |
| Session 5 | 48.00 | 47.00 | 40.00 | 45.00 | Session 5 | 54.00 | 54.00 | 56.00 | 54.67 |
| Session 6 | 50.00 | 51.00 | 59.00 | 53.33 | Session 6 | 60.00 | 64.00 | 64.00 | 62.67 |
| Session 7 | 60.00 | 61.00 | 65.00 | 62.00 | Session 7 | 68.00 | 67.00 | 65.00 | 66.67 |
| Session 8 | 67.00 | 68.00 | 70.00 | 68.33 | Session 8 | 69.00 | 72.00 | 68.00 | 69.67 |
| Session 9 | 70.00 | 68.00 | 69.00 | 69.00 | Session 9 | 70.00 | 71.00 | 71.00 | 70.67 |
| Session 10 | 71.00 | 69.00 | 70.00 | 70.00 | Session 10 | 72.00 | 70.00 | 70.00 | 70.67 |
| Retention | 65.00 | 67.00 | 71.00 | 67.67 | | | | | |

Tables 8 and 9 below represent the maximum lingual force exerted across the three trials for Tongue Tip strength and Dorsum strength respectively.

**Table 8-** ***Maximum dorsum force***

*Maximum dorsum force obtained at the beginning of each sessions and then again immediately following practice of 50 slurp-swallow exercises for subject 2*

| *Tongue Tip Force in Pascals (kPa) at the Beginning of Each Session-Maximum Achieved Across 3 Trials* | *Tongue Tip Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Maximum Achieved Across 3 Trials* |
|---|---|

| *Session* | *Max. Force* |
|---|---|
| Baseline | 19.00 |
| Session 2 | 19.00 |
| Session 3 | 19.00 |
| Session 4 | 20.00 |
| Session 5 | 24.00 |
| Session 6 | 25.00 |
| Session 7 | 29.00 |
| Session 8 | 35.00 |
| Session 9 | 36.00 |
| Session 10 | 37.00 |
| Retention | 33.00 |

| *Session* | *Max. Force* |
|---|---|
| Session 1 | 12.00 |
| Session 2 | 14.00 |
| Session 3 | 20.00 |
| Session 4 | 25.00 |
| Session 5 | 28.00 |
| Session 6 | 30.00 |
| Session 7 | 37.00 |
| Session 8 | 39.00 |
| Session 9 | 42.00 |
| Session 10 | 47.00 |

**Table 9**- ***Maximum tongue tip force***

*Maximum tongue tip force obtained at the beginning of each sessions and then again immediately following practice of 50 slurp-swallow exercises for subject 2*

| *Tongue Dorsum Force in Pascals (kPa) at the Beginning of Each Session-Maximum Achieved Across 3 Trials* | |
|---|---|
| *Session* | *Max. Force* |
| Baseline | 32.00 |
| Session 2 | 37.00 |
| Session 3 | 38.00 |
| Session 4 | 47.00 |
| Session 5 | 48.00 |
| Session 6 | 59.00 |
| Session 7 | 65.00 |
| Session 8 | 70.00 |
| Session 9 | 70.00 |
| Session 10 | 71.00 |
| Retention | 71.00 |

| *Tongue Dorsum Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Maximum Achieved Across 3 Trials* | |
|---|---|
| *Session* | *Max. Force* |
| Session 1 | 35.00 |
| Session 2 | 40.00 |
| Session 3 | 44.00 |
| Session 4 | 51.00 |
| Session 5 | 56.00 |
| Session 6 | 64.00 |
| Session 7 | 68.00 |
| Session 8 | 72.00 |
| Session 9 | 71.00 |
| Session 10 | 72.00 |

Subject 2 demonstrated increases in both measures of superior lingual strength. The trend lines below in Figures 7 and 8 illustrate the increases in tongue tip strength in both measurements taken at the beginning of each session and those taken immediately following completion of exercises. Evaluation of the linear trend lines and the +/- 2 SD bands indicate that there was a significant increase in both of measures tongue tip strength.

**Figure 7- Tongue Tip Force in Pascals**

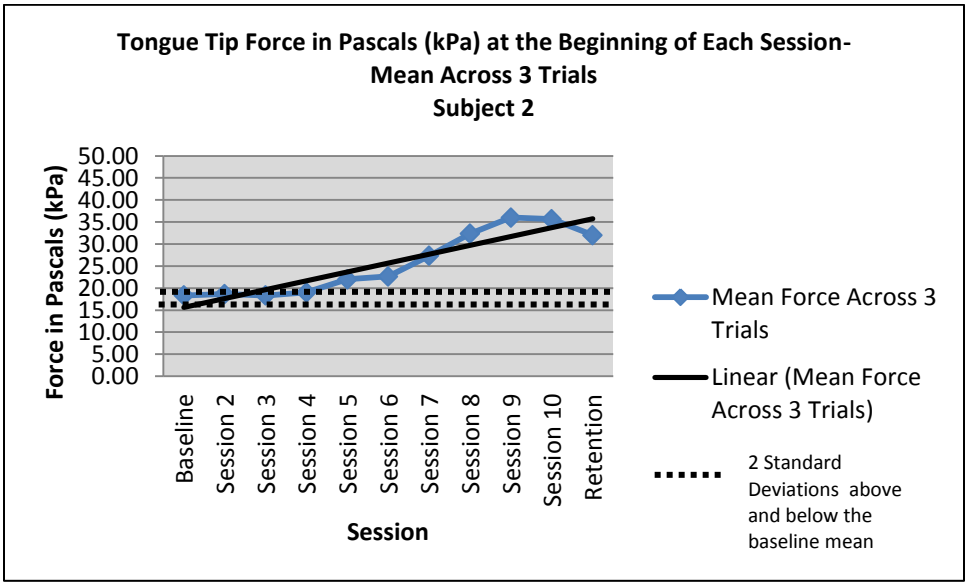
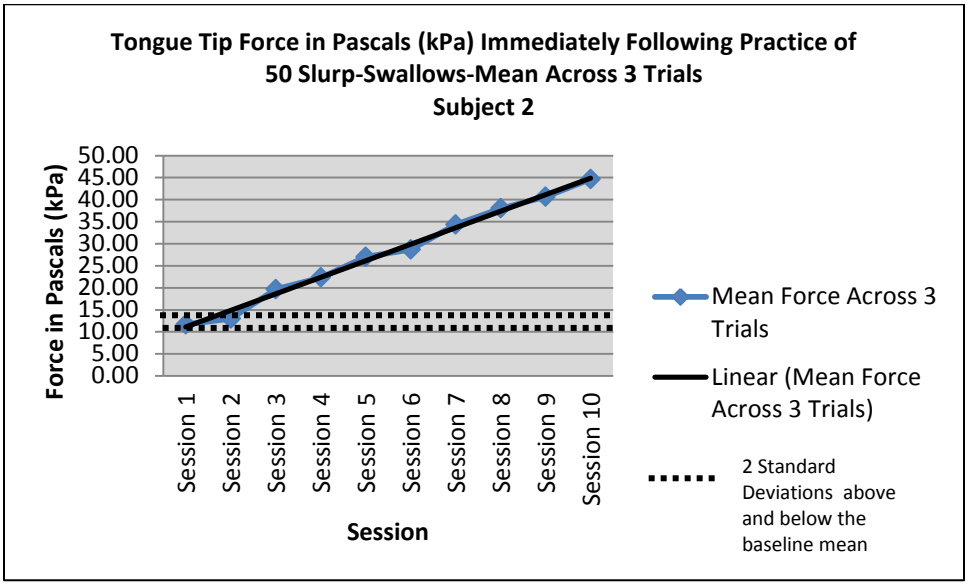


**Figure 8- Tongue Tip Force in Pascals (kPa**




Analysis of the trend lines and the +/- 2 SD bands for dorsum strength indicates significant increases in both tongue tip measures as well.

**Figure 9- Tongue Dorsum Force in Pascals (kPa)**

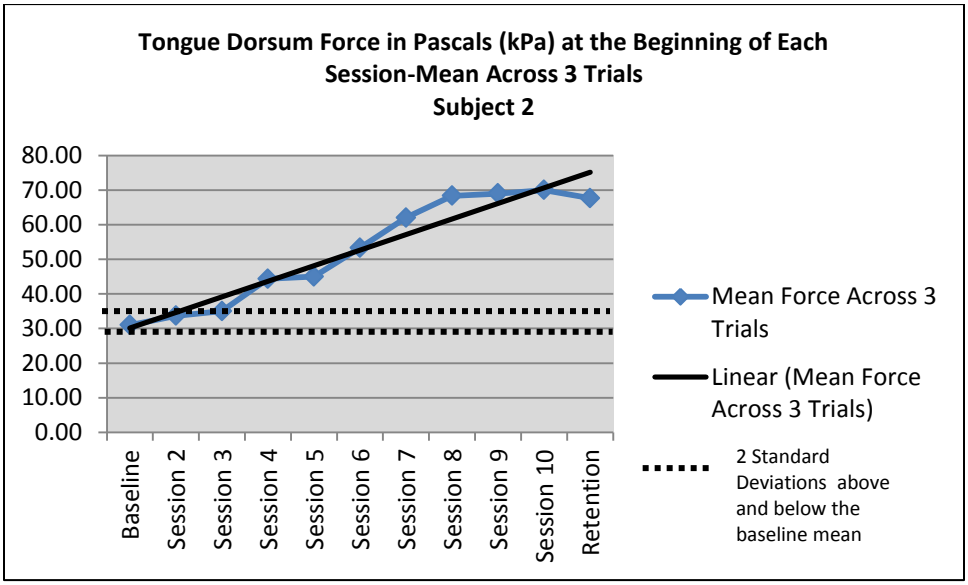
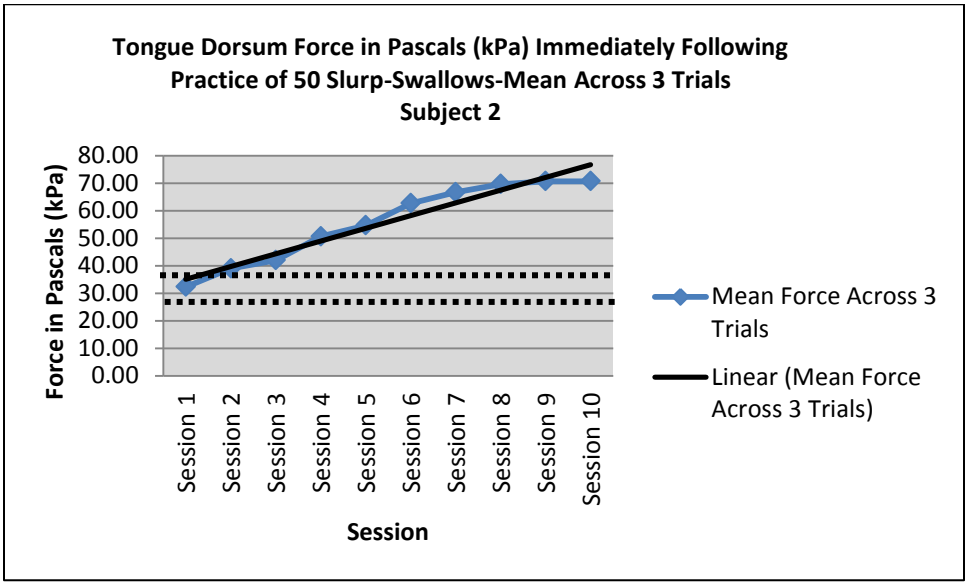


**Figure 10- Tongue Dorsum Force in Pascals (kPa)**




While increases in measurements of superior lingual force can be seen in the above Figures, analysis of both lip strength and sustained vowel /a/ measurements, concluded that there was no significant increase in measurements of these two variables. Figure 11 illustrates this with a level trend line and measurements falling within the +/- 2 SD band for lip strength. In Figure 12 the trend line for sustained vowel is relatively flat as well, and all scores fall within the +/- 2 SD band.

**Figure 11- Lip Strength in Pascals (kPa)**

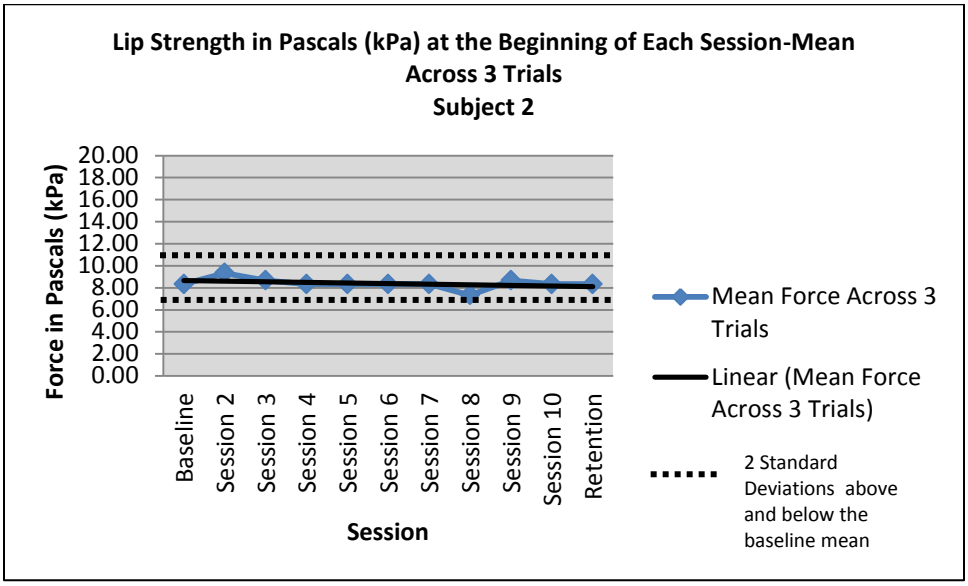
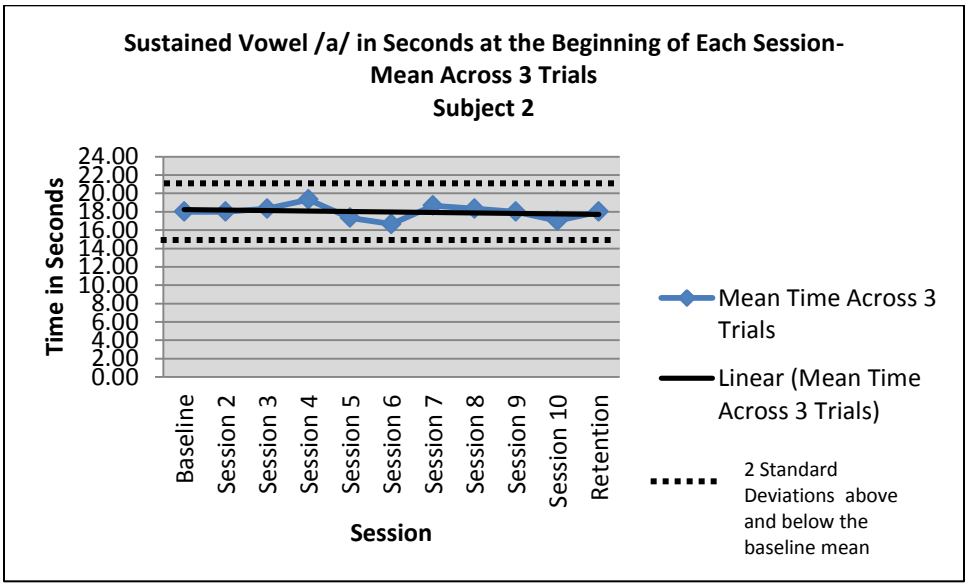



**Figure 12- Sustained Vowel /a/**




Subject 2 demonstrated increases in measurements of superior lingual force and maintenance of measurements of the control variables. Analysis of the data indicates that it was the exposure to the slurp-swallow exercise, and not factor such as maturation, that was responsible for the increases in superior lingual force.

*Summary:*

Subject 2 was a 33 year 2 month old female who demonstrated mild to moderate tongue thrust. She attended 10 treatment sessions over 10 consecutive days. Measurements of superior lingual force indicate increased coordination and strength across baseline and treatment sessions, while control measurements of sustained vowel /a/ and lip strength did not increase across treatment sessions. The 50 repetitions of the slurp-swallow were interrupted by the need to moisten the oral cavity with water throughout the treatment sessions. That pause in activity was often accompanied by brief conversation. Subject 2 demonstrated retained superior lingual strength and coordination with measurements above baseline following 2 weeks without treatment. Subject 2 expressed a high level of motivation to correctly perform the slurp-swallow and to remediate the tongue thrust.

***Subject 3***

Subject 3 was a 33 year 8 month old female who presented with type II malocclusion. Treatment was provided at Cole Memorial. Subject 3 had previously sought orthodontic treatment for her narrow palate and overbite, however the orthodontist diagnosed her with tongue thrust. Subject 3 indicated to the researcher that she was informed that she would need to wear a device long term to block the tongue from protruding during swallow in order to maintain the new dental alignment that braces would achieve. Oromyofunctional therapy was never introduced as a possibility to her. At that time she declined further orthodontic work and did not pursue braces. The case history obtained during the Idaho State University Tongue Thrust Protocol did not reveal a significant history of poor oral habits such as digit sucking or prolonged bottle use.

Observation of the oral mechanism at rest revealed slightly open lips during breathing. Observation of swallow with lips open revealed tongue protrusion beyond the cutting surface of the upper incisors, she was unable to retain solid or liquid boluses and moderate debris remained on the tongue after the swallow if a solid bolus. The subject was observed to use auxiliary muscles groups when swallowing, with chin, neck and shoulder movement during swallows, even with lips closed. Excessive labial musculature was noted, with a lower lip that was considered large in proportion to the upper lip. When asked to swallow with lips apart for assessment purposes, these movements were greatly exaggerated. Palpation of the masseter during swallow revealed excess engagement of these muscles during swallow. Treatment sessions occurred over a 3 week period, with one 4 day weekend due to a family medical emergency for the subject. The subject reported, during the initial treatment session that the exercises where "extremely difficult." Severe extraneous movements were noted, with the entire upper body involved in the process of moving the tongue posteriorly during the slurp-swallow. Secondary movements such as clenching the chair or hitting the fist on the table were observed. The patient reported that less effort was required to perform the exercise by the third treatment session. Observations by the researcher and a licensed speech-language pathologist, who was present for the baseline session as well, noted that extraneous movements decreased by the third session and were completely absent during the seventh through tenth sessions. The subject was observed to have a much more relaxed posture by session seven and there was no visible muscular tension in the shoulder, neck or jaw as there had been during the baseline session. Frequent breaks were requested by the subject to drink water and relax a moment before resuming the 50

repetitions of the exercise. The frequency of the breaks decreased such that by the 9th and 10th session the subject stopped only once half way through the set Retention measurements were collected 4 weeks after the last treatment session with no treatment provided during that time.

Baseline measures were collected across three trials for each variable with very little variability between each trial. Tongue tip strength across baseline and treatment sessions is illustrated in Table 10. Dorsum strength across baseline and treatment sessions is depicted in Table 11.

**Table 10-** ***Tongue tip strength measurements in kPa***

*Tongue tip strength measurements in kPa with baseline, and means taken at the beginning of the session and means immediately following practice 50 repetitions of the slurp-swallow exercise for subject 3*

| *Tongue Tip Force in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials* | | | | | *Tongue Tip Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Mean Across 3 Trials* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Session* | *Trial 1* | *Trial 2* | *Trial 3* | *Mean Force* | *Session* | *Trial 1* | *Trial 2* | *Trial 3* | *Mean Force* |
| Baseline | 13.00 | 12.00 | 9.00 | 11.33 | Session 1 | 17.00 | 18.00 | 11.00 | 15.33 |
| Session 2 | 13.00 | 13.00 | 12.00 | 12.67 | Session 2 | 11.00 | 12.00 | 11.00 | 11.33 |
| Session 3 | 15.00 | 17.00 | 27.00 | 19.67 | Session 3 | 13.00 | 14.00 | 14.00 | 13.67 |
| Session 4 | 15.00 | 17.00 | 19.00 | 17.00 | Session 4 | 15.00 | 16.00 | 17.00 | 16.00 |
| Session 5 | 19.00 | 28.00 | 20.00 | 22.33 | Session 5 | 20.00 | 22.00 | 25.00 | 22.33 |
| Session 6 | 8.00 | 9.00 | 8.00 | 8.33 | Session 6 | 20.00 | 20.00 | 21.00 | 20.33 |
| Session 7 | 18.00 | 14.00 | 22.00 | 18.00 | Session 7 | 15.00 | 14.00 | 14.00 | 14.33 |
| Session 8 | 16.00 | 21.00 | 13.00 | 16.67 | Session 8 | 12.00 | 12.00 | 13.00 | 12.33 |
| Session 9 | 16.00 | 17.00 | 22.00 | 18.33 | Session 9 | 22.00 | 23.00 | 16.00 | 20.33 |
| Session 10 | 19.00 | 29.00 | 25.00 | 24.33 | Session 10 | 22.00 | 18.00 | 18.00 | 19.33 |
| Retention | 23.00 | 20.00 | 28.00 | 23.67 | | | | | |

**Table 11-** ***Dorsum strength measurements in kPa***

*Dorsum strength measurements in kPa with baseline, and means taken at the beginning of the session and means immediately following practice 50 repetitions of the slurp-swallow exercise for subject 3*

| *Tongue Dorsum Force in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials* | | | | | *Tongue Dorsum Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Mean Across 3 Trials* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Session* | *Trial 1* | *Trial 2* | *Trial 3* | *Mean Force* | *Session* | *Trial 1* | *Trial 2* | *Trial 3* | *Mean Force* |
| Baseline | 40.00 | 41.00 | 43.00 | 41.33 | Session 1 | 40 | 41 | 41 | 40.67 |
| Session 2 | 52.00 | 45.00 | 48.00 | 48.33 | Session 2 | 49 | 56 | 53 | 52.67 |
| Session 3 | 51.00 | 54.00 | 55.00 | 53.33 | Session 3 | 48 | 55 | 51 | 51.33 |
| Session 4 | 55.00 | 56.00 | 45.00 | 52.00 | Session 4 | 56 | 56 | 58 | 56.67 |
| Session 5 | 53.00 | 58.00 | 49.00 | 53.33 | Session 5 | 45 | 55 | 47 | 49.00 |
| Session 6 | 56.00 | 50.00 | 55.00 | 53.67 | Session 6 | 44 | 43 | 46 | 44.33 |
| Session 7 | 55.00 | 53.00 | 47.00 | 51.67 | Session 7 | 54 | 57 | 54 | 55.00 |
| Session 8 | 50.00 | 56.00 | 53.00 | 53.00 | Session 8 | 56 | 56 | 57 | 56.33 |
| Session 9 | 52.00 | 54.00 | 49.00 | 51.67 | Session 9 | 60 | 56 | 54 | 56.67 |
| Session 10 | 54.00 | 56.00 | 56.00 | 55.33 | Session 10 | 60 | 54 | 62 | 58.67 |
| Retention | 55.00 | 50.00 | 56.00 | 53.67 | | | | | |

Tables 12 and 13 below represent the maximum lingual force exerted across the three trials for Tongue Tip strength and Dorsum strength respectively.

**Table 12-** ***Maximum dorsum force***

*Maximum dorsum force obtained at the beginning of each sessions and then again immediately following practice of 50 slurp-swallow exercises for subject 3*

| *Tongue Tip Force in Pascals (kPa) at the Beginning of Each Session-Maximum Achieved Across 3 Trials* | |
|---|---|
| *Session* | *Max. Force-Beginning of Each Session* |
| Baseline | 13.00 |

| *Tongue Tip Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Maximum Achieved Across 3 Trials* | |
|---|---|
| *Session* | *Max. Force Immediately Following Practice of Slurp Swallow* |
| Session 1 | 18.00 |

| | |
|---|---|
| Session 2 | 13.00 |
| Session 3 | 27.00 |
| Session 4 | 19.00 |
| Session 5 | 28.00 |
| Session 6 | 8.00 |
| Session 7 | 22.00 |
| Session 8 | 21.00 |
| Session 9 | 22.00 |
| Session 10 | 29.00 |
| Retention | 28.00 |

| | |
|---|---|
| Session 2 | 12.00 |
| Session 3 | 14.00 |
| Session 4 | 17.00 |
| Session 5 | 25.00 |
| Session 6 | 21.00 |
| Session 7 | 15.00 |
| Session 8 | 13.00 |
| Session 9 | 23.00 |
| Session 10 | 22.00 |

**Table 13-** ***Maximum tongue tip force***

*Maximum tongue tip force obtained at the beginning of each sessions and then again immediately following practice of 50 slurp-swallow exercises for subject 3*

| *Tongue Dorsum Force in Pascals (kPa) at the Beginning of Each Session-Maximum Achieved Across 3 Trials* | |
|---|---|
| *Session* | *Max. Force-Beginning of Each Session* |
| Baseline | 43.00 |
| Session 2 | 52.00 |
| Session 3 | 55.00 |
| Session 4 | 56.00 |
| Session 5 | 58.00 |
| Session 6 | 56.00 |
| Session 7 | 55.00 |
| Session 8 | 56.00 |
| Session 9 | 54.00 |
| Session 10 | 56.00 |
| Retention | 56.00 |

| *Tongue Dorsum Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Maximum Achieved Across 3 Trials* | |
|---|---|
| *Session* | *Max. Force Immediately Following Practice of Slurp Swallow* |
| Session 1 | 41.00 |
| Session 2 | 56.00 |
| Session 3 | 55.00 |
| Session 4 | 58.00 |
| Session 5 | 55.00 |
| Session 6 | 46.00 |
| Session 7 | 57.00 |
| Session 8 | 57.00 |
| Session 9 | 60.00 |
| Session 10 | 62.00 |

Analysis of the measurements from baseline through the 10 treatments sessions revealed that Subject 3 demonstrated increases in both measures of tongue tip strength. However, in both measurements a decrease in scores was noted following the 4 day break. Figures 13 and 14 (below) illustrate the overall increase in measurements for superior lingual force. A trend line which corresponds to the measurements for each session has a positive slope for both measurements taken at the beginning of each session and those taken following the completion of exercises each session. Though not as dramatic an increase as other subjects more than two measurements fall outside of the +/- 2 SD band indicating significant increases for Tongue Tip strength at the beginning of each session. However, Figure 14 reveals that a significant increase in measures taken immediately after practice of 50 slurp-swallow exercises did not occur. Given the degree of the extraneous movements and observable effort that completion of the task required of this subject this lack of significant increase could be due to system fatigue. Another more likely possibility is that scores decreased dramatically after the 4 day break in treatment and had that break not occurred continued increase in strength may have been observed.

**Figure 13- Tongue Tip Force in Pascals (kPa) at the Beginning of Each Session**

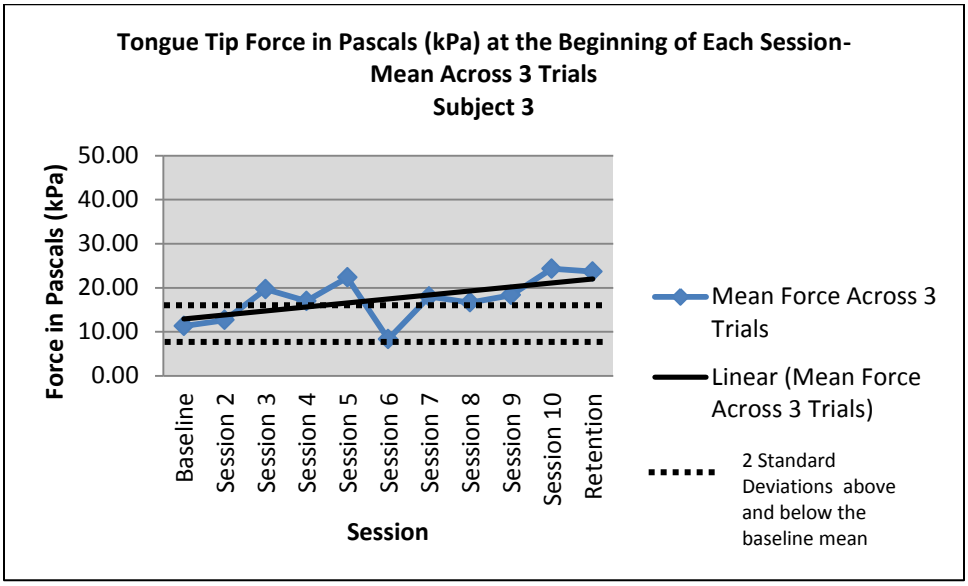



**Figure 14- Tongue Tip Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows**

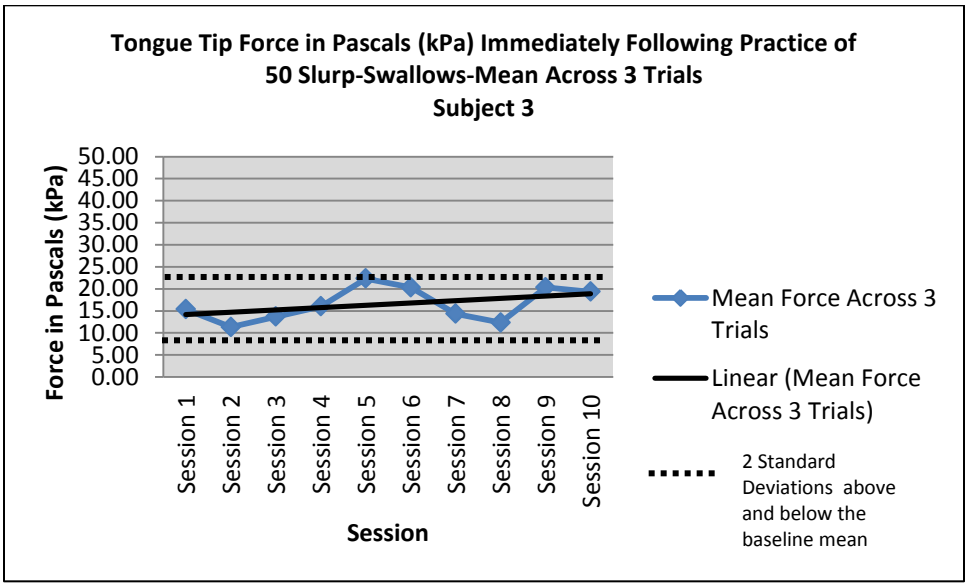



Figure 15 illustrates the increase in dorsum strength from the baseline measure through measures in subsequent sessions taken prior to engaging in the slurp-swallow exercise each session. Figure 16 depicts the increase in dorsum strength recorded immediately following the 50 repetitions of the slurp-swallow exercise for all 10 treatment sessions. In the case of the dorsum measurements a decrease after the 4 day

break in treatment occurred only for measurements taken after completion of the exercise. Analysis of the measurements indicates an increase in dorsum strength across the 10 treatment sessions, with a greater increase in treatment measures taken immediately after treatment each session. The trend line for both dorsum measurement fallows a positive slope and for both measurements more than two data points fall outside of the +/- 2 SD band indicating a significant increase. Tongue tip strength remained above baseline after 4 weeks without treatment.

**Figure 15- Tongue Dorsum Force in Pascals (kPa) at the Beginning of Each Session**

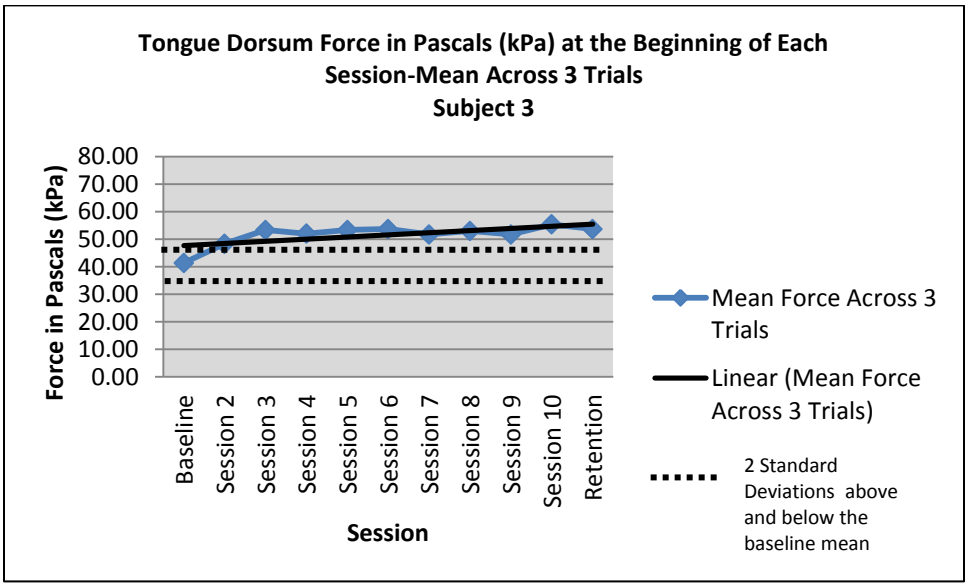
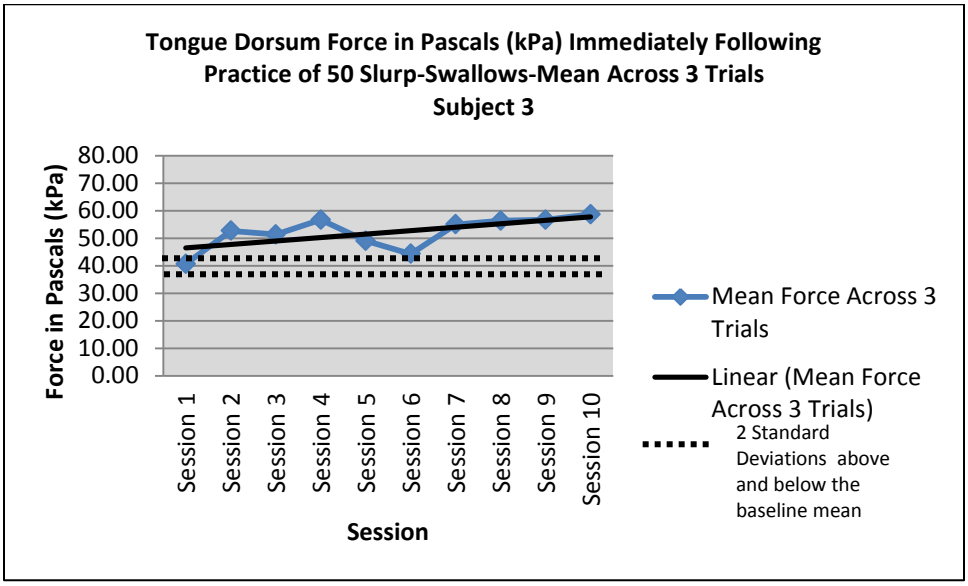


**Figure 16- Tongue Dorsum Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallow**




Analysis of the scores obtained for lip strength and sustained vowel /a/ reveals very little variability in these measures across the 10 treatment sessions. Figure 17 illustrates this with a level trend line for lip strength; the trend line in the graph depicts the stable measurements across each treatment session. The trend line for sustained vowel /a/, which is very level, can be seen in Figure 18. For both control variables the all data points lie within the +/- 2 SD bands which indicates that no significant changes occurred. Dorsum strength remained above baseline after 4 weeks without treatment.

**Figure 17- Lip Strength in Pascals (kPa) at the Beginning of Each Session**

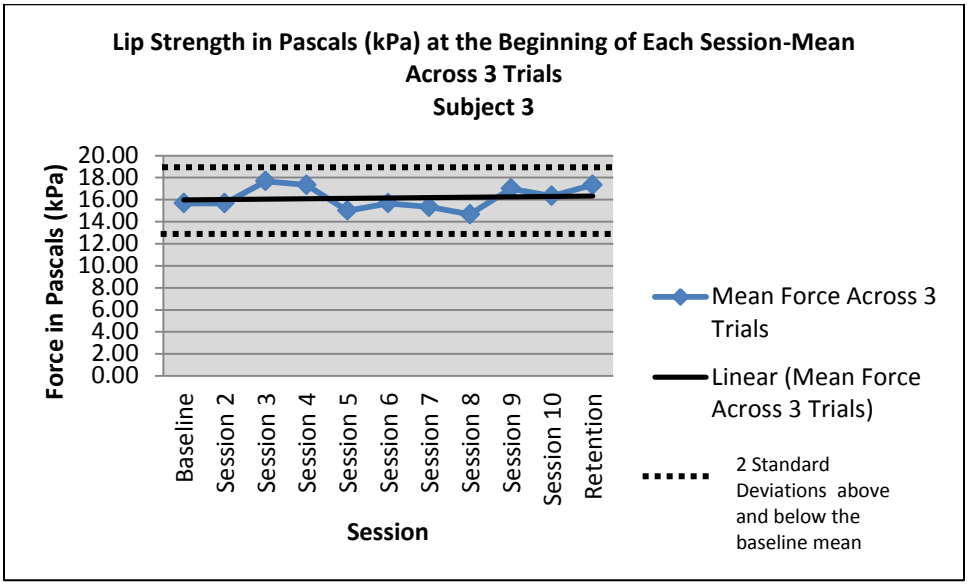
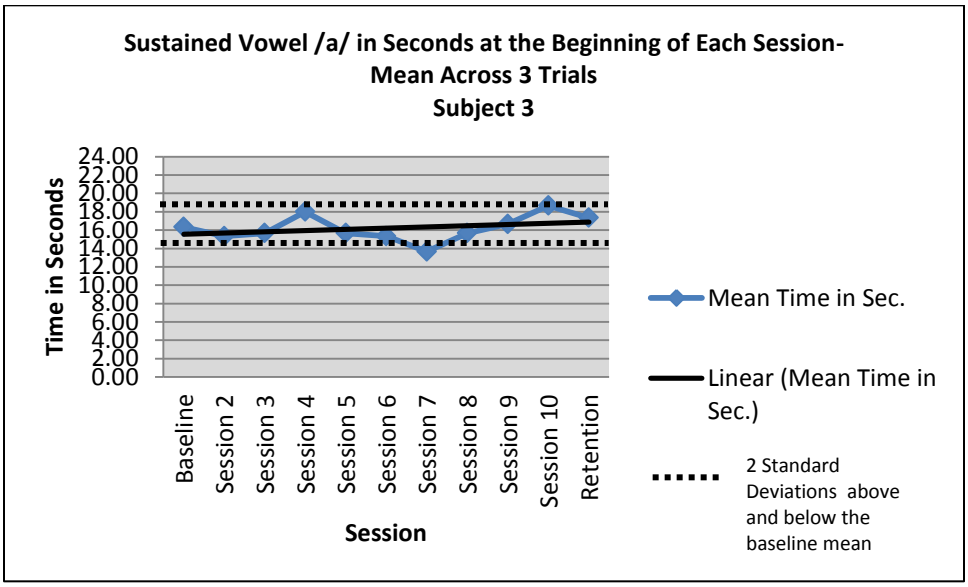



**Figure 18- Sustained Vowel /a/**




Analysis of the measurements of each variable revealed that superior lingual force and coordination increased as demonstrated by increases in tongue tip and dorsum force, while control variables of sustained vowel and lip strength remained stable across 10 treatment sessions utilizing the slurp-swallow exercise. It is therefore concluded that the

exposure to the slurp-swallow is responsible for the changes that occurred in superior lingual force and coordination rather than extraneous factors.

*Summary:*

Subject 3 was a 33 year 8 month old female with a severe tongue thrust. She presented with uncorrected type II malocclusion and extraneous muscle movement and visible tension when swallowing. As she progressed through the treatment sessions which utilized 50 repetitions of the slurp-swallow exercise, there was an observable decrease in these movements and tension. Significant increases in tongue tip strength measurements taken at the beginning of each session and dorsum strength measurements taken at the beginning of each session and immediately following completion of 50 repetitions of the slurp-swallow were observed. No significant change in the control variables was observed. The increases in superior lingual force are attributed to the practice of the slurp-swallow during treatment sessions rather than extraneous factors such as maturation, as there was no increase in sustained vowel time or lip strength. The subject demonstrated retention of superior lingual force and coordination when retention measures revealed greater measurements of tongue tip and dorsum were maintained above baseline following a 4 week period without treatment.

***Subject 4***

Subject 4 was a 33 year 6 month old female, who had been previously diagnosed with tongue thrust at Idaho State University's Meridian Clinic. The presence of tongue thrust was confirmed using the Idaho State University Tongue Thrust Protocol. She exhibited a slight but visible lateral tongue protrusion during swallow and spillage was noted on liquid swallows. Subject 4 presented with mild tongue thrust with no significant

history of poor oral habits and no malocclusion. Being aware of tongue thrust and its potential issues caused this subject to express that she was highly motivated to participate in this study and to correct her tongue thrust. Treatment sessions were conducted over 10 consecutive days. The subject reported decreased difficulty in the performance on the slurp-swallow as treatment sessions progressed. In initial sessions secondary behaviors such as hand motions and head thrusting were observed during the initiation of the posterior tongue movement and swallow. The patient expressed frustration with herself when she was unable to or had extreme difficulty keeping the tongue retracted. As treatment progressed she reported less difficulty and tension and there was an observable decrease in secondary behaviors. Subject 4 demonstrated increases in measures of tongue tip and dorsum strength across treatment sessions as illustrated in Tables 7 and 8 below. Measurements to determine if increased superior lingual force was retained after a period without treatment were collected approximately 5 weeks after the 10$^{th}$ treatment session. Tongue tip strength and dorsum strength measurements remained above baseline after the non-treatment period.

**Table 14-** ***Tongue tip strength measurements in kPa***

*Tongue tip strength measurements in kPa with baseline, and means taken at the beginning of the session and means immediately following practice 50 repetitions of the slurp-swallow exercise for subject 4*

| *Tongue Tip Force in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials* | | | | | *Tongue Tip Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Mean Across 3 Trials* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Session | *Trial 1* | *Trial 2* | *Trial 3* | *Mean Force* | *Session* | *Trial 1* | *Trial 2* | *Trial 3* | *Mean Force* |
| Baseline | 34.00 | 26.00 | 24.00 | 28.00 | Session 1 | 28.00 | 28.00 | 21.00 | 25.67 |
| Session 2 | 28.00 | 29.00 | 24.00 | 27.00 | Session 2 | 38.00 | 38.00 | 36.00 | 37.33 |
| Session 3 | 29.00 | 26.00 | 30.00 | 28.33 | Session 3 | 34.00 | 35.00 | 34.00 | 34.33 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Session 4 | 29.00 | 30.00 | 26.00 | 28.33 | Session 4 | 37.00 | 32.00 | 32.00 | 33.67 |
| Session 5 | 38.00 | 35.00 | 36.00 | 36.33 | Session 5 | 43.00 | 41.00 | 45.00 | 43.00 |
| Session 6 | 35.00 | 35.00 | 36.00 | 35.33 | Session 6 | 36.00 | 39.00 | 35.00 | 36.67 |
| Session 7 | 36.00 | 32.00 | 26.00 | 31.33 | Session 7 | 39.00 | 31.00 | 34.00 | 34.67 |
| Session 8 | 34.00 | 34.00 | 34.00 | 34.00 | Session 8 | 45.00 | 38.00 | 35.00 | 39.33 |
| Session 9 | 32.00 | 28.00 | 33.00 | 31.00 | Session 9 | 47.00 | 35.00 | 39.00 | 40.33 |
| Session 10 | 36.00 | 28.00 | 37.00 | 33.67 | Session 10 | 42.00 | 67.00 | 41.00 | 50.00 |
| Retention | 50.00 | 52.00 | 50.00 | 50.67 | | | | | |

**Table 15-** ***Dorsum strength measurements in kPa***

*Dorsum strength measurements in kPa with baseline, and means taken at the beginning of the session and means immediately following practice 50 repetitions of the slurp-swallow exercise for subject 4*

| *Tongue Dorsum Force in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials* | | | | | *Tongue Dorsum Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Mean Across 3 Trials* | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Session* | *Trial 1* | *Trial 2* | *Trial 3* | *Mean Force* | *Session* | *Trial 1* | *Trial 2* | *Trial 3* | *Mean Force* |
| Baseline | 28.00 | 39.00 | 38.00 | 35.00 | Session 1 | 40.00 | 40.00 | 35.00 | 38.33 |
| Session 2 | 35.00 | 32.00 | 33.00 | 33.33 | Session 2 | 48.00 | 46.00 | 47.00 | 47.00 |
| Session 3 | 51.00 | 47.00 | 46.00 | 48.00 | Session 3 | 54.00 | 53.00 | 55.00 | 54.00 |
| Session 4 | 58.00 | 53.00 | 53.00 | 54.67 | Session 4 | 59.00 | 60.00 | 60.00 | 59.67 |
| Session 5 | 60.00 | 61.00 | 52.00 | 57.67 | Session 5 | 69.00 | 64.00 | 65.00 | 66.00 |
| Session 6 | 67.00 | 54.00 | 60.00 | 60.33 | Session 6 | 61.00 | 58.00 | 65.00 | 61.33 |
| Session 7 | 63.00 | 61.00 | 61.00 | 61.67 | Session 7 | 60.00 | 67.00 | 62.00 | 63.00 |
| Session 8 | 61.00 | 63.00 | 67.00 | 63.67 | Session 8 | 72.00 | 66.00 | 66.00 | 68.00 |
| Session 9 | 69.00 | 68.00 | 63.00 | 66.67 | Session 9 | 72.00 | 67.00 | 66.00 | 68.33 |
| Session 10 | 70.00 | 66.00 | 64.00 | 66.67 | Session 10 | 72.00 | 69.00 | 64.00 | 68.33 |
| Retention | 68.00 | 71.00 | 68.00 | 69.00 | | | | | |

Tables 16 and 17 below represent the maximum lingual force exerted across the three trials for Tongue Tip strength and Dorsum strength respectively.

**Table 16-** ***Maximum tongue tip force***

*Maximum tongue tip force obtained at the beginning of each sessions and then again immediately following practice of 50 slurp-swallow exercises for subject 4*

| *Tongue Tip Force in Pascals (kPa) at the Beginning of Each Session-Maximum Achieved Across 3 Trials* | |
|---|---|
| *Session* | *Max. Force-Beginning of Each Session* |
| Baseline | 34.00 |
| Session 2 | 29.00 |
| Session 3 | 30.00 |
| Session 4 | 30.00 |
| Session 5 | 38.00 |
| Session 6 | 36.00 |
| Session 7 | 36.00 |
| Session 8 | 34.00 |
| Session 9 | 33.00 |
| Session 10 | 37.00 |
| Retention | 52.00 |

| *Tongue Tip Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Maximum Achieved Across 3 Trials* | |
|---|---|
| *Session* | *Max. Force Immediately Following Practice of Slurp Swallow* |
| Session 1 | 28.00 |
| Session 2 | 38.00 |
| Session 3 | 35.00 |
| Session 4 | 37.00 |
| Session 5 | 45.00 |
| Session 6 | 39.00 |
| Session 7 | 39.00 |
| Session 8 | 45.00 |
| Session 9 | 47.00 |
| Session 10 | 67.00 |

**Table 17-** ***Maximum dorsum force***

*Maximum dorsum force obtained at the beginning of each sessions and then again immediately following practice of 50 slurp-swallow exercises for subject 4*

| *Tongue Dorsum Force in Pascals (kPa) at the Beginning of Each Session-Maximum Achieved Across 3 Trials* | |
|---|---|
| *Session* | *Max. Force-Beginning of Each Session* |
| Baseline | 39.00 |
| Session 2 | 35.00 |

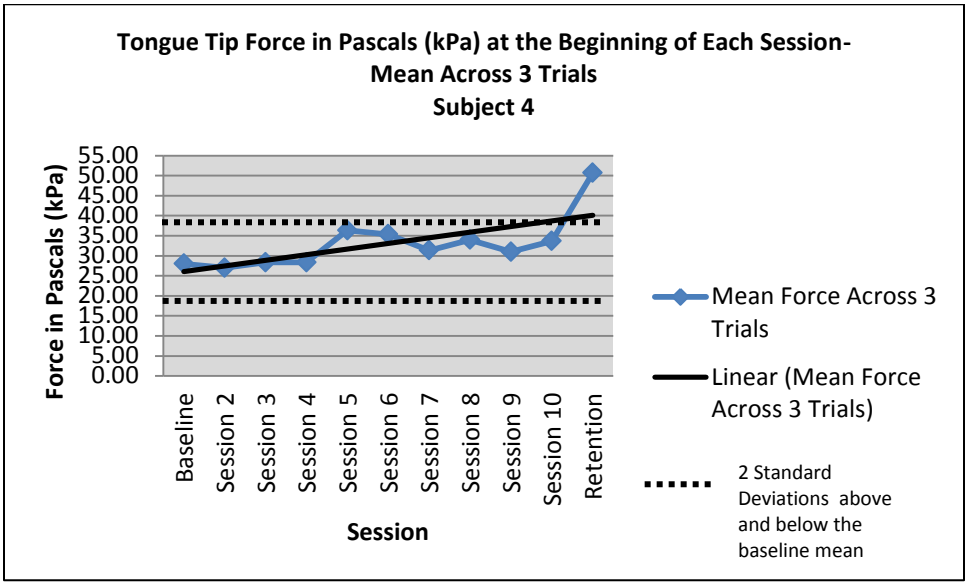
| *Tongue Dorsum Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Maximum Achieved Across 3 Trials* | |
|---|---|
| *Session* | *Max. Force Immediately Following Practice of Slurp Swallow* |
| Session 1 | 40.00 |
| Session 2 | 48.00 |

| | |
|---|---|
| Session 3 | 51.00 |
| Session 4 | 58.00 |
| Session 5 | 61.00 |
| Session 6 | 67.00 |
| Session 7 | 61.00 |
| Session 8 | 67.00 |
| Session 9 | 69.00 |
| Session 10 | 70.00 |
| Retention | 71.00 |

| | |
|---|---|
| Session 3 | 55.00 |
| Session 4 | 60.00 |
| Session 5 | 69.00 |
| Session 6 | 65.00 |
| Session 7 | 67.00 |
| Session 8 | 72.00 |
| Session 9 | 72.00 |
| Session 10 | 72.00 |

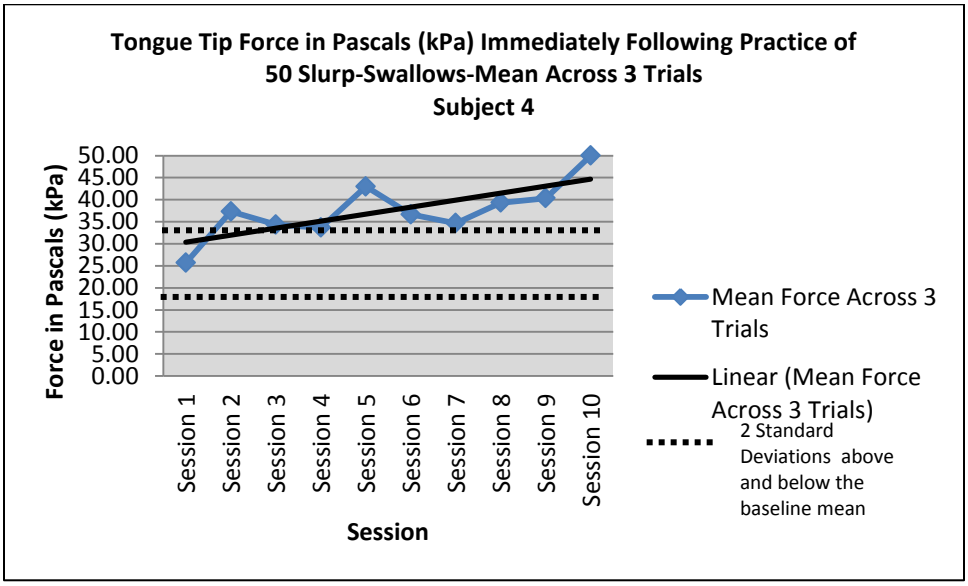
Subject 4 demonstrated significant increases in tongue tip strength in measures taken immediately following completion of 50 repetitions of the slurp-swallow exercise , with more stable scores obtained in measures prior to the exercise each session. Only one data point lays outside of the +/- 2SD for tongue tip measures taken at the beginning of each session. Baseline measures for Subject 4 taken in 3 trials have a range of 10, which is far greater than any range for baseline measures collected for the other subjects. The +/-2 SD bands were calculated based on the 3 baseline measures. The SD for subject 4 in tongue tip force at the beginning of the session was 5.29, which is also higher than other calculated SD throughout this study. Figure 19 below depicts the linera trend line associated with the slightly increasing scores obtained for baseline and measures taken at the beginning of each session.

**Figure 19- Tongue Tip Force in Pascals (kPa) at the Beginning of Each Session**




Data collected immediately following 50 repetitions of the slurp-swallow indicates a greater increase in tongue tip strength than was indicated in scores taken before practice. Figure 20 illustrates this increase with scores falling along a trend line with a distinctly increasing slope. Greater than 2 measures fall outside of the +/- 2 SD band indicating a significant increase.

**Figure 20- Tongue Tip Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows**



For subject 4 analysis of the baseline and treatment measures indicates dorsum strength also increased. The linear trend line for each group of measurements have positive slopes and most scores fall outside of the +/- 2 SD band indicating a significant increase. Measures of dorsum strength collected at the beginning of each session are illustrated in Figure 21, those collected immediately following exercise completion can be found in Figure 22.

**Figure 21- Tongue Dorsum Force in Pascals (kPa) at the Beginning of Each Session**

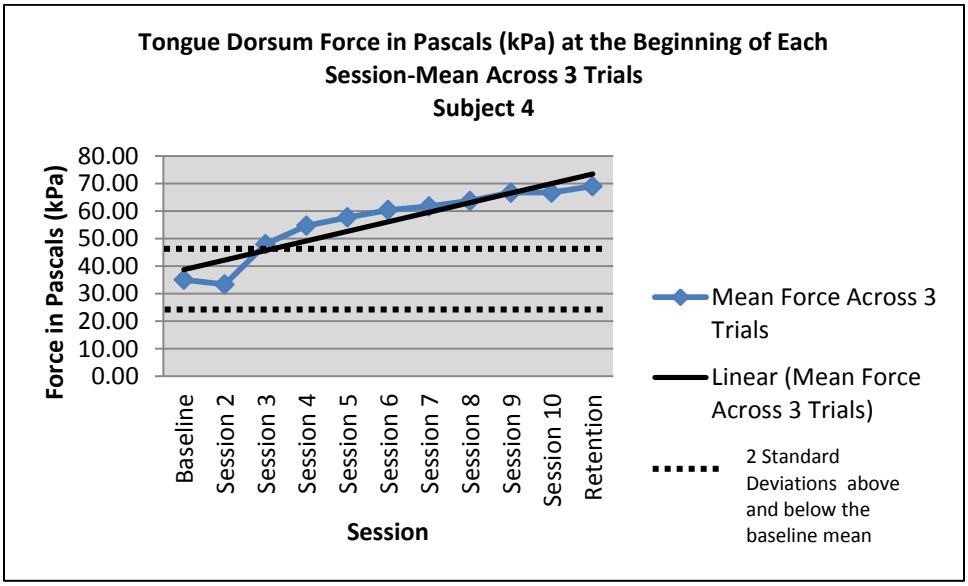
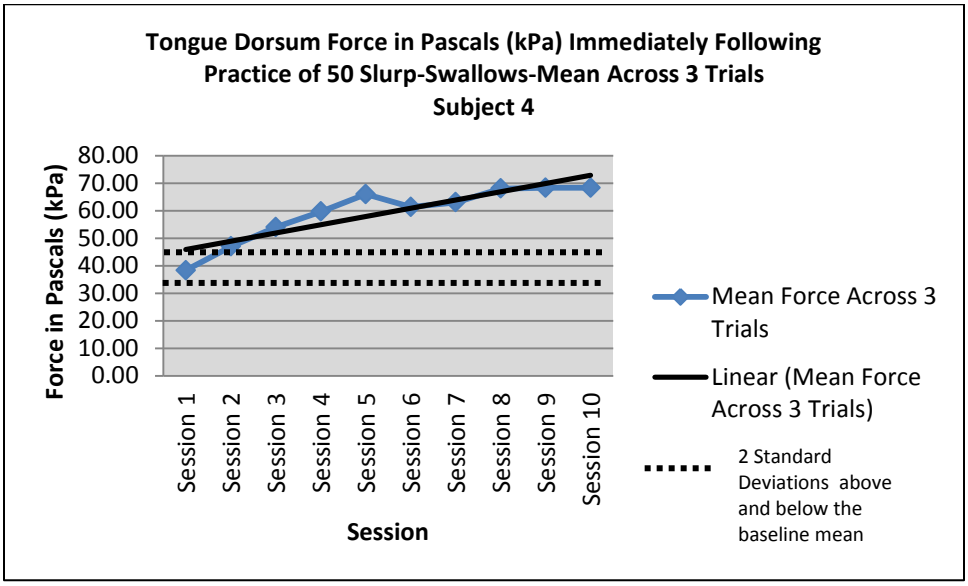


**Figure 22- Tongue Dorsum Force in Pascals (kPa) at the Beginning of Each Session**




A relatively flat linear trend line for sustained vowel /a/ can be seen in Figure 24, with all scores falling within the +/- 2 SD band indicating no significant change. Figure 23 illustrates the results collected for lip strength. For subject 4 there was a significant increase in lip strength measures collected at the beginning of each session. The final measurements collected for retention purposes finds the mean across the three trials to be the same as that obtained at baseline. Analysis of this data indicates, that given the stable measurements across treatment sessions for sustained vowel /a/, the participation in practice of the slurp-swallow exercise could be responsible for the increase in superior lingual force measurements, but slight increases in lip strength cannot be ignored.

**Figure 23- Lip Strength in Pascals (kPa) at the Beginning of Each Session**

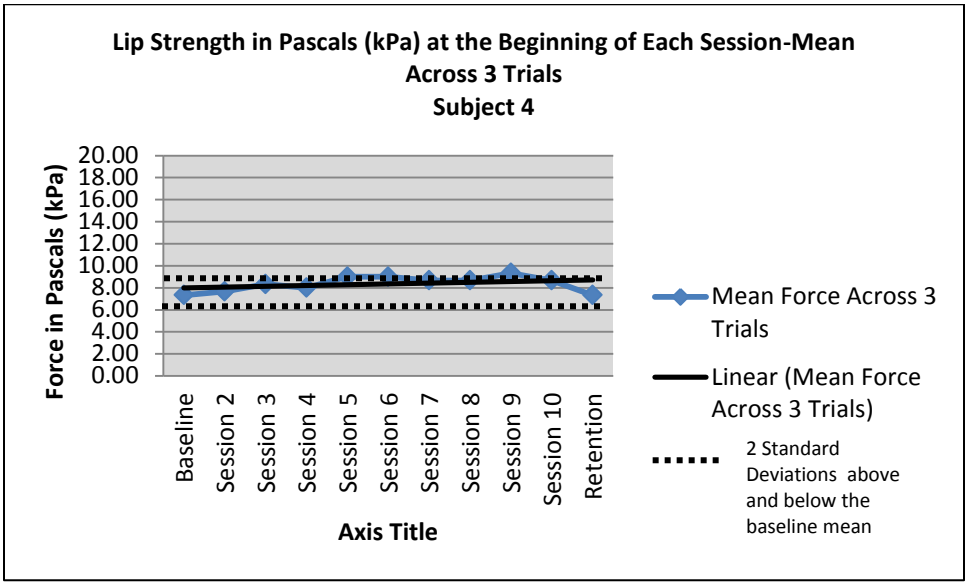
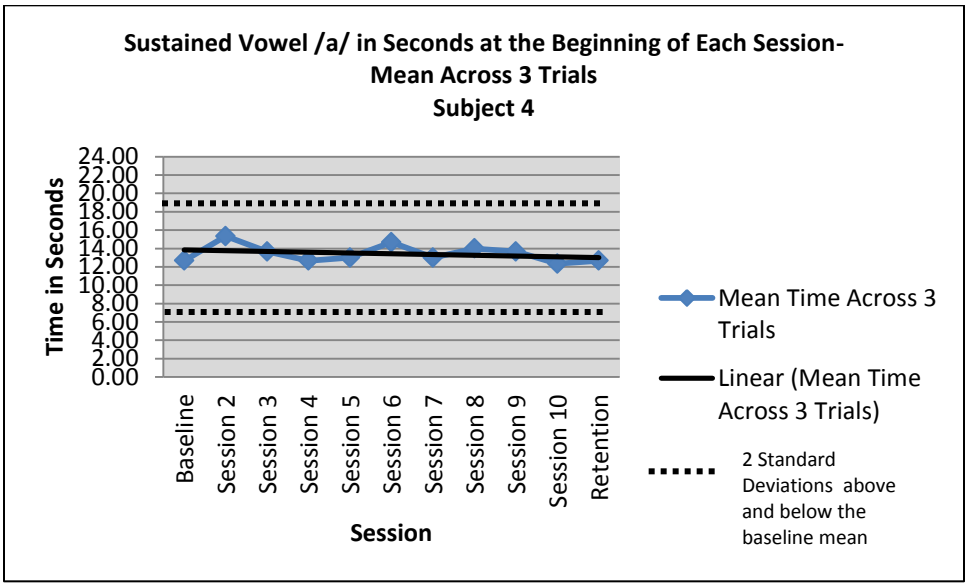



**Figure 24- Sustained Vowel /a/**




Analysis of the data reveals that significant increases occurred for tongue tip force immediately following 50 repetitions of the slurp-swallow exercise and for dorsum force measurements taken at the beginning of each session and immediately following treatment each session. While one control variable, the sustained vowel /a/, remained stable the second, lip strength, was found to have significant changes across treatment

sessions. It therefore cannot be confirmed that the slurp-swallow was responsible for increases in superior lingual force for subject 4. The wide variability in baseline measures for tongue tip force at the beginning of sessions could have been a factor in confirming a significant increase in tongue tip force. For all measures of the dependent variables, retention measures remained above baseline. Measures of control variables collected 5 weeks post treatment with no treatment provided in that period remained stable.

*Summary:*

Subject 4, a 33 year 6 month old female, demonstrated significant increases in tongue tip strength measures collected immediately following 50 repetitions of the slurp-swallow, relatively stable scores in measures collected at the beginning of the sessions and increases in both measures of dorsum force. Control variable sustained vowel /a/ remained stable across treatment sessions, while lip force was found to have a significant change. When compared against baseline measures the subject demonstrated retention of strength and coordination after 5 weeks without treatment.

## Chapter IV-Discussion

The purpose of the current study was to determine if the slurp-swallow exercise completed in 10 block-practice sessions would increase superior lingual force in individuals with tongue thrust. Three out of four subjects demonstrated increases in superior lingual force with stable measures of the control variables, thus supporting the research hypothesis that completion of 50 repetitions of the slurp-swallow increases superior lingual force. Control variables remained stable for three out of four subjects, suggesting that it was the participation in the slurp-swallow exercise and not extraneous factors such as maturation or participation in a research study that was responsible for the increases in lingual force. Subject 4 demonstrated dramatic significant increases in dorsum force and significant increases in tongue tip strength measured immediately following completion of 50 repetitions of the slurp-swallow exercise. Significant changes were observed in measures of lip strength, though less dramatic than other observed increases. While the data did not meet the criteria for statistical significance set forth by the research design, the data should be viewed with a critical eye and caution. Tongue tip strength taken at the beginning of each session fell along a positive trend line, but wide variability in the baseline created very wide +/- 2 SD bands.

Past research regarding the effectiveness of the slurp-swallow has been conducted solely on children. This study sought to broaden the subject age range to include adults. Motivation was a factor indicated by Buchanan (2007) that should be considered in future research. All three adults in this study indicated a desire to complete the study and to remediate their tongue thrust, whereas the child was unable to express that idea. The

child subject was compliant and motivated by verbal praise. The factor of motivation was addressed through using adult subjects that exhibit intrinsic motivation.

With the statistically positive results for three of the four subjects results of this study contribute to the body of evidence that supports the use of the slurp-swallow exercise as an effective exercise in the remediation of tongue thrust.

### *Summary and Conclusions*

Given that three out of four participants demonstrated increased superior lingual force and retained muscle strength as far as five weeks post-treatment indicates that the slurp-swallow is an effective exercise for increasing superior lingual strength. Intrinsic motivation to correct tongue thrust was noted through interactions with participants wherein they verbally expressed a desire to remediate their tongue thrust for various reasons. They reported that water was desirable to maintain moisture in the mouth when practicing the slurp-swallow exercise across 50 repetitions. Each of the subjects required breaks from repetitions of the exercise. These four subjects had water available at all times. The intention of this study was to complete the 50 repetitions of the slurp-swallow following a block practice schedule as utilized by Buchanan in 2007, but the nature of the exercise with repeated swallows and sucking of the moisture of the mouth through the "slurp" naturally lent itself to a random practice schedule.

### *Limitations and Future Research*

This study consisted of 4 subjects, one child age 7 years 8 months and three adults ages 33 year 2 months, 33 years 8 months, and 33 years 6 months with a mean age for all subjects of 27 years 0 months and a mean age for adults only of 33 years 5 months . Reliability of these finding would have benefitted from an increased sample size with subjects from a wide range of ages. The sample included 1 male and 3 females, along

with an increased number of subjects, a balanced gender distribution is suggested for future research. Three of the four subjects were from Potter County Pennsylvania, the fourth was from Colorado. Three of the four subjects identified themselves as Caucasian, and the fourth subject identified herself as being from Asian-American decent. Previous studies investigating the slurp-swallow have included only children. These facts emphasize the need for not only gender diversity, but age and cultural balance for future research as well.

The brief duration of this study, with 10 treatment sessions, is another limitation. The frequency and duration of treatment of dysphagia in the clinical setting is vastly different than the schedule of treatment set forth herein. Patients are often seen 1-3 times a week and up to 5 times a week in the acute setting, over several weeks or months. Future research should consider the typical clinical setting and apply that format to this particular exercise.

Additionally, while no subjects where informed of which measures were the control variables and which were the dependent variables the adults were able to deduce this. Each subject was informed as to the purpose of the study. The adults each expressed motivation to correct their tongue thrust. Careful procedures with a high level of procedural reliability and strong correlation coefficients for inter-rater reliability indicate that the results of the study were due to the participation in the slurp-swallow exercise and not outside bias, however future researcher should look for ways to decrease potential bias through other methodology such as using a double-blind or randomized assignment to alternate treatment groups.

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# Appendix A: Data

Subject 1:

| Sustained Vowel /a/ in Seconds at the Beginning of Each Session-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Time in Sec. |
| Baseline | 7 | 9 | 11 | 9.00 |
| Session 2 | 9 | 11 | 10 | 10.00 |
| Session 3 | 10 | 12 | 8 | 10.00 |
| Session 4 | 7 | 9 | 12 | 9.33 |
| Session 5 | 11 | 8 | 9 | 9.33 |
| Session 6 | 9 | 11 | 7 | 9.00 |
| Session 7 | 10 | 11 | 9 | 10.00 |
| Session 8 | 7 | 11 | 9 | 9.00 |
| Session 9 | 10 | 12 | 8 | 10.00 |
| Session 10 | 9 | 7 | 11 | 9.00 |
| Retention | 11 | 7 | 9 | 9.00 |

| Lip Strength in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
| Baseline | 10 | 12 | 10 | 10.67 |
| Session 2 | 9 | 13 | 10 | 10.67 |
| Session 3 | 10 | 11 | 12 | 11.00 |
| Session 4 | 11 | 11 | 9 | 10.33 |
| Session 5 | 10 | 12 | 11 | 11.00 |
| Session 6 | 11 | 10 | 9 | 10.00 |
| Session 7 | 10 | 12 | 8 | 10.00 |
| Session 8 | 8 | 9 | 12 | 9.67 |
| Session 9 | 10 | 10 | 11 | 10.33 |
| Session 10 | 10 | 9 | 10 | 9.67 |
| Retention | 10 | 11 | 10 | 10.33 |

| Tongue Tip Force in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
| Baseline | 10 | 10 | 8 | 9.33 |
| Session 2 | 8 | 11 | 10 | 9.67 |
| Session 3 | 12 | 12 | 11 | 11.67 |
| Session 4 | 12 | 13 | 12 | 12.33 |
| Session 5 | 14 | 12 | 12 | 12.67 |
| Session 6 | 17 | 18 | 16 | 17.00 |
| Session 7 | 16 | 17 | 19 | 17.33 |
| Session 8 | 22 | 19 | 21 | 20.67 |
| Session 9 | 22 | 19 | 21 | 20.67 |
| Session 10 | 23 | 22 | 21 | 22.00 |
| Retention | 19 | 20 | 20 | 19.67 |

| Tongue Tip Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
| Session 1 | 12 | 13 | 11 | 12.00 |
| Session 2 | 13 | 13 | 12 | 12.67 |
| Session 3 | 14 | 12 | 15 | 13.67 |
| Session 4 | 14 | 15 | 14 | 14.33 |
| Session 5 | 13 | 15 | 13 | 13.67 |
| Session 6 | 15 | 17 | 17 | 16.33 |
| Session 7 | 20 | 19 | 21 | 20.00 |
| Session 8 | 20 | 17 | 19 | 18.67 |
| Session 9 | 24 | 24 | 23 | 23.67 |
| Session 10 | 24 | 22 | 24 | 23.33 |

| Tongue Dorsum Force in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials |
|---|

| Tongue Dorsum Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Mean Across 3 Trials |
|---|

| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
|---|---|---|---|---|
| Baseline | 16 | 15 | 14 | 15.00 |
| Session 2 | 16 | 14 | 14 | 14.67 |
| Session 3 | 17 | 18 | 20 | 18.33 |
| Session 4 | 24 | 23 | 26 | 24.33 |
| Session 5 | 37 | 37 | 39 | 37.67 |
| Session 6 | 44 | 43 | 40 | 42.33 |
| Session 7 | 48 | 48 | 50 | 48.67 |
| Session 8 | 50 | 57 | 55 | 54.00 |
| Session 9 | 59 | 58 | 58 | 58.33 |
| Session 10 | 58 | 62 | 60 | 60.00 |
| Retention | 56 | 54 | 57 | 55.67 |

| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
|---|---|---|---|---|
| Session 1 | 18 | 20 | 22 | 20.00 |
| Session 2 | 25 | 20 | 23 | 22.67 |
| Session 3 | 25 | 25 | 23 | 24.33 |
| Session 4 | 33 | 30 | 31 | 31.33 |
| Session 5 | 42 | 41 | 43 | 42.00 |
| Session 6 | 45 | 47 | 49 | 47.00 |
| Session 7 | 56 | 58 | 57 | 57.00 |
| Session 8 | 60 | 60 | 61 | 60.33 |
| Session 9 | 60 | 58 | 63 | 60.33 |
| Session 10 | 66 | 67 | 68 | 67.00 |

Subject 2:

| Sustained Vowel /a/ in Seconds at the Beginning of Each Session-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Time in Sec. |
| Baseline | 17 | 17 | 20 | 18.00 |
| Session 2 | 16 | 17 | 21 | 18.00 |
| Session 3 | 17 | 20 | 18 | 18.33 |
| Session 4 | 20 | 20 | 18 | 19.33 |
| Session 5 | 18 | 17 | 17 | 17.33 |
| Session 6 | 17 | 17 | 16 | 16.67 |
| Session 7 | 20 | 19 | 17 | 18.67 |
| Session 8 | 18 | 20 | 17 | 18.33 |
| Session 9 | 17 | 17 | 20 | 18.00 |
| Session 10 | 17 | 15 | 19 | 17.00 |
| Retention | 17 | 19 | 18 | 18.00 |

| Lip Strength in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
| Baseline | 7 | 9 | 9 | 8.33 |
| Session 2 | 11 | 9 | 8 | 9.33 |
| Session 3 | 8 | 9 | 9 | 8.67 |
| Session 4 | 7 | 9 | 9 | 8.33 |
| Session 5 | 9 | 7 | 9 | 8.33 |
| Session 6 | 8 | 8 | 9 | 8.33 |
| Session 7 | 9 | 8 | 8 | 8.33 |
| Session 8 | 8 | 7 | 7 | 7.33 |
| Session 9 | 8 | 9 | 9 | 8.67 |
| Session 10 | 9 | 9 | 7 | 8.33 |
| Retention | 9 | 7 | 9 | 8.33 |

| Tongue Tip Force in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
| Baseline | 18 | 19 | 18 | 18.33 |
| Session 2 | 18 | 19 | 19 | 18.67 |
| Session 3 | 19 | 19 | 17 | 18.33 |
| Session 4 | 19 | 20 | 18 | 19.00 |
| Session 5 | 22 | 24 | 20 | 22.00 |

| Tongue Tip Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
| Session 1 | 11 | 12 | 12 | 11.67 |
| Session 2 | 13 | 12 | 14 | 13.00 |
| Session 3 | 18 | 20 | 21 | 19.67 |
| Session 4 | 21 | 21 | 25 | 22.33 |
| Session 5 | 27 | 28 | 26 | 27.00 |

| | | | | |
|---|---|---|---|---|
| Session 6 | 24 | 25 | 19 | 22.67 |
| Session 7 | 27 | 26 | 29 | 27.33 |
| Session 8 | 30 | 32 | 35 | 32.33 |
| Session 9 | 35 | 37 | 36 | 36.00 |
| Session 10 | 34 | 37 | 36 | 35.67 |
| Retention | 32 | 33 | 31 | 32.00 |

| | | | | |
|---|---|---|---|---|
| Session 6 | 28 | 28 | 30 | 28.67 |
| Session 7 | 31 | 35 | 37 | 34.33 |
| Session 8 | 37 | 38 | 39 | 38.00 |
| Session 9 | 41 | 39 | 42 | 40.67 |
| Session 10 | 44 | 43 | 47 | 44.67 |
| Retention | 65 | 67 | 71 | 67.67 |

Tongue Dorsum Force in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials

| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
|---|---|---|---|---|
| Baseline | 30 | 32 | 31 | 31.00 |
| Session 2 | 31 | 33 | 37 | 33.67 |
| Session 3 | 38 | 30 | 37 | 35.00 |
| Session 4 | 42 | 44 | 47 | 44.33 |
| Session 5 | 48 | 47 | 40 | 45.00 |
| Session 6 | 50 | 51 | 59 | 53.33 |
| Session 7 | 60 | 61 | 65 | 62.00 |
| Session 8 | 67 | 68 | 70 | 68.33 |
| Session 9 | 70 | 68 | 69 | 69.00 |
| Session 10 | 71 | 69 | 70 | 70.00 |

Tongue Dorsum Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Mean Across 3 Trials

| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
|---|---|---|---|---|
| Session 1 | 35 | 31 | 31 | 32.33 |
| Session 2 | 38 | 39 | 40 | 39.00 |
| Session 3 | 42 | 40 | 44 | 42.00 |
| Session 4 | 50 | 51 | 51 | 50.67 |
| Session 5 | 54 | 54 | 56 | 54.67 |
| Session 6 | 60 | 64 | 64 | 62.67 |
| Session 7 | 68 | 67 | 65 | 66.67 |
| Session 8 | 69 | 72 | 68 | 69.67 |
| Session 9 | 70 | 71 | 71 | 70.67 |
| Session 10 | 72 | 70 | 70 | 70.67 |

Subject 3:

| Sustained Vowel /a/ in Seconds at the Beginning of Each Session-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Time in Sec. |
| Baseline | 17 | 17 | 15 | 16.33 |
| Session 2 | 17 | 14 | 15 | 15.33 |
| Session 3 | 11 | 17 | 19 | 15.67 |
| Session 4 | 20 | 16 | 18 | 18.00 |
| Session 5 | 19 | 16 | 12 | 15.67 |
| Session 6 | 15 | 15 | 16 | 15.33 |
| Session 7 | 14 | 10 | 17 | 13.67 |
| Session 8 | 18 | 14 | 15 | 15.67 |
| Session 9 | 18 | 15 | 17 | 16.67 |
| Session 10 | 21 | 20 | 15 | 18.67 |
| Retention | 20 | 15 | 17 | 17.33 |

| Lip Strength in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
| Baseline | 16 | 14 | 17 | 15.67 |
| Session 2 | 18 | 15 | 14 | 15.67 |
| Session 3 | 18 | 19 | 16 | 17.67 |
| Session 4 | 16 | 17 | 19 | 17.33 |
| Session 5 | 15 | 15 | 15 | 15.00 |
| Session 6 | 17 | 16 | 14 | 15.67 |
| Session 7 | 16 | 16 | 14 | 15.33 |
| Session 8 | 13 | 15 | 16 | 14.67 |
| Session 9 | 15 | 19 | 17 | 17.00 |
| Session 10 | 15 | 17 | 17 | 16.33 |
| Retention | 17 | 17 | 18 | 17.33 |

| Tongue Tip Force in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
| Baseline | 13 | 12 | 9 | 11.33 |
| Session 2 | 13 | 13 | 12 | 12.67 |
| Session 3 | 15 | 17 | 27 | 19.67 |
| Session 4 | 15 | 17 | 19 | 17.00 |
| Session 5 | 19 | 28 | 20 | 22.33 |
| Session 6 | 8 | 9 | 8 | 8.33 |
| Session 7 | 18 | 14 | 22 | 18.00 |
| Session 8 | 16 | 21 | 13 | 16.67 |
| Session 9 | 16 | 17 | 22 | 18.33 |
| Session 10 | 19 | 29 | 25 | 24.33 |
| Retention | 23 | 20 | 28 | 23.67 |

| Tongue Tip Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
| Session 1 | 17 | 18 | 11 | 15.33 |
| Session 2 | 11 | 12 | 11 | 11.33 |
| Session 3 | 13 | 14 | 14 | 13.67 |
| Session 4 | 15 | 16 | 17 | 16.00 |
| Session 5 | 20 | 22 | 25 | 22.33 |
| Session 6 | 20 | 20 | 21 | 20.33 |
| Session 7 | 15 | 14 | 14 | 14.33 |
| Session 8 | 12 | 12 | 13 | 12.33 |
| Session 9 | 22 | 23 | 16 | 20.33 |
| Session 10 | 22 | 18 | 18 | 19.33 |

| Tongue Dorsum Force in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
| Baseline | 40 | 41 | 43 | 41.33 |
| Session 2 | 52 | 45 | 48 | 48.33 |
| Session 3 | 51 | 54 | 55 | 53.33 |
| Session 4 | 55 | 56 | 45 | 52.00 |
| Session 5 | 53 | 58 | 49 | 53.33 |
| Session 6 | 56 | 50 | 55 | 53.67 |
| Session 7 | 55 | 53 | 47 | 51.67 |
| Session 8 | 50 | 56 | 53 | 53.00 |
| Session 9 | 52 | 54 | 49 | 51.67 |
| Session 10 | 54 | 56 | 56 | 55.33 |

| Tongue Dorsum Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
| Session 1 | 40 | 41 | 41 | 40.67 |
| Session 2 | 49 | 56 | 53 | 52.67 |
| Session 3 | 48 | 55 | 51 | 51.33 |
| Session 4 | 56 | 56 | 58 | 56.67 |
| Session 5 | 45 | 55 | 47 | 49.00 |
| Session 6 | 44 | 43 | 46 | 44.33 |
| Session 7 | 54 | 57 | 54 | 55.00 |
| Session 8 | 56 | 56 | 57 | 56.33 |
| Session 9 | 60 | 56 | 54 | 56.67 |
| Session 10 | 60 | 54 | 62 | 58.67 |

| | | | | |
|---|---|---|---|---|
| Retention | 55 | 50 | 56 | 53.67 |

Subject 4:

| Sustained Vowel /a/ in Seconds at the Beginning of Each Session-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Time in Sec. |
| Baseline | 11 | 11 | 16 | 12.67 |
| Session 2 | 15 | 20 | 11 | 15.33 |
| Session 3 | 12 | 14 | 15 | 13.67 |
| Session 4 | 16 | 13 | 9 | 12.67 |
| Session 5 | 15 | 12 | 12 | 13.00 |
| Session 6 | 14 | 15 | 15 | 14.67 |
| Session 7 | 14 | 12 | 13 | 13.00 |
| Session 8 | 14 | 12 | 16 | 14.00 |
| Session 9 | 13 | 15 | 13 | 13.67 |
| Session 10 | 14 | 12 | 11 | 12.33 |
| Retention | 12 | 13 | 13 | 12.67 |

| Lip Strength in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
| Baseline | 8 | 7 | 7 | 7.33 |
| Session 2 | 7 | 8 | 8 | 7.67 |
| Session 3 | 9 | 7 | 9 | 8.33 |
| Session 4 | 8 | 8 | 8 | 8.00 |
| Session 5 | 10 | 8 | 9 | 9.00 |
| Session 6 | 9 | 10 | 8 | 9.00 |
| Session 7 | 8 | 9 | 9 | 8.67 |
| Session 8 | 8 | 9 | 9 | 8.67 |
| Session 9 | 9 | 9 | 10 | 9.33 |
| Session 10 | 9 | 8 | 9 | 8.67 |
| Retention | 7 | 8 | 7 | 7.33 |

| Tongue Tip Force in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
| Baseline | 34 | 26 | 24 | 28.00 |
| Session 2 | 28 | 29 | 24 | 27.00 |
| Session 3 | 29 | 26 | 30 | 28.33 |
| Session 4 | 29 | 30 | 26 | 28.33 |
| Session 5 | 38 | 35 | 36 | 36.33 |
| Session 6 | 35 | 35 | 36 | 35.33 |
| Session 7 | 36 | 32 | 26 | 31.33 |
| Session 8 | 34 | 34 | 34 | 34.00 |
| Session 9 | 32 | 28 | 33 | 31.00 |
| Session 10 | 36 | 28 | 37 | 33.67 |
| Retention | 50 | 52 | 50 | 50.67 |

| Tongue Tip Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
| Session 1 | 28 | 28 | 21 | 25.67 |
| Session 2 | 38 | 38 | 36 | 37.33 |
| Session 3 | 34 | 35 | 34 | 34.33 |
| Session 4 | 37 | 32 | 32 | 33.67 |
| Session 5 | 43 | 41 | 45 | 43.00 |
| Session 6 | 36 | 39 | 35 | 36.67 |
| Session 7 | 39 | 31 | 34 | 34.67 |
| Session 8 | 45 | 38 | 35 | 39.33 |
| Session 9 | 47 | 35 | 39 | 40.33 |
| Session 10 | 42 | 67 | 41 | 50.00 |

| Tongue Dorsum Force in Pascals (kPa) at the Beginning of Each Session-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
| Baseline | 28 | 39 | 38 | 35.00 |
| Session 2 | 35 | 32 | 33 | 33.33 |
| Session 3 | 51 | 47 | 46 | 48.00 |
| Session 4 | 58 | 53 | 53 | 54.67 |
| Session 5 | 60 | 61 | 52 | 57.67 |
| Session 6 | 67 | 54 | 60 | 60.33 |
| Session 7 | 63 | 61 | 61 | 61.67 |
| Session 8 | 61 | 63 | 67 | 63.67 |

| Tongue Dorsum Force in Pascals (kPa) Immediately Following Practice of 50 Slurp-Swallows-Mean Across 3 Trials | | | | |
|---|---|---|---|---|
| Session | Trial 1 | Trial 2 | Trial 3 | Mean Force |
| Session 1 | 40 | 40 | 35 | 38.33 |
| Session 2 | 48 | 46 | 47 | 47.00 |
| Session 3 | 54 | 53 | 55 | 54.00 |
| Session 4 | 59 | 60 | 60 | 59.67 |
| Session 5 | 69 | 64 | 65 | 66.00 |
| Session 6 | 61 | 58 | 65 | 61.33 |
| Session 7 | 60 | 67 | 62 | 63.00 |
| Session 8 | 72 | 66 | 66 | 68.00 |

| | | | | |
|---|---|---|---|---|
| Session 9 | 69 | 68 | 63 | 66.67 |
| Session 10 | 70 | 66 | 64 | 66.67 |
| Retention | 68 | 71 | 68 | 69.00 |

| | | | | |
|---|---|---|---|---|
| Session 9 | 72 | 67 | 66 | 68.33 |
| Session 10 | 72 | 69 | 64 | 68.33 |

Appendix B: Idaho State University Human Subject Committee Application

**APPLICATION TO INVOLVE HUMAN SUBJECTS IN RESEARCH**

**SECTION I: COVER PAGE AND ASSURANCES**

Project Title: The Treatment Efficacy of the Oromyofunctional Exercise in Strengthening the Tongue in Persons with Tongue Thrust
Principal Investigator: Dr. Tony Seikel
Co-Investigators: Misty Torrey, Rachel Durrant, Amy Dunn
University Status: Professor
Department: Communication Sciences and Disorders, and Education of the Deaf
Campus Mail Stop: 8116 Mailing Address if not on campus: NA
Email: seikel@isu.edu Phone: 208-282-4037
Faculty Sponsor: Dr. Tony Seikel
Department: Communication Sciences and Disorders, and Education of the Deaf
Campus Mail Stop: 8116 Mailing Address if not on campus:
Email: seikel@isu.edu Phone: 208-282-4037
External Funding If Yes, Funding Agency: NA
Has this proposal, or one substantially like this, been submitted to other IRBs?
If so please list: NA
Are you using information secured from a health provider, such as a hospital, clinic, pharmacy, doctor's office?
Do you have a patient/provider relationship with any of the potential subjects? No
Proposal Status (Choose one):
Copies Needed (Choose one):
I certify that the information provided in this application is complete and correct.
I understand that as the Principal Investigator, I have ultimate responsibility for the conduct of the study, the ethical performance of the project, the protection of the rights and welfare of human subjects, and strict adherence to any stipulations imposed by the HSC.
I agree to comply with all ISU policies and procedures, as well as with all applicable Federal, State and local laws regarding the protection of human subjects in research, including, but not limited to, the following:
> performing the project by qualified personnel according to the approved protocol
> implementing no changes in the approved protocol or consent form without prior HSC approval (except in the case of an emergency, if necessary to safeguard the well-being of human subjects)
> obtaining the legally effective informed consent from human subjects or their legally responsible representative, and using only the currently approved, stamped consent form with human subjects
> Promptly reporting significant or untoward adverse effects to the HSC in writing within five (5) working days of occurrence
> If I am unable to direct this research as specified in the approved protocol, I will arrange for a co-investigator to assume direct responsibility during my absence. Either this person will be named as a co-investigator in this protocol or I will inform the HSC by letter, in advance, of such an arrangement.

_____ (Signature is required)
Principal Investigator Date

By my signature as advisor on this research protocol, I certify that the student is knowledgeable about the regulations and policies governing research with human subjects and has sufficient training and experience to conduct this particular study in accordance with the approved protocol. In addition,
> I agree to meet with the principal investigator on a regular basis to monitor the progress of the study.
> Should problems arise during the course of the study, I agree to be available, personally, to supervise the investigator in solving them.
> I assure that the principal investigator will promptly report significant or untoward adverse effects to the HSC in writing within five (5) working days of occurrence.
> If I will be unavailable, I will arrange for an alternate faculty advisor to assume responsibility during my absence, and I will inform the HSC by letter of such an arrangement.

_____ (Must have signature if PI is student)
Faculty Advisor* Date
* A faculty advisor must be a member of the ISU faculty. The faculty advisor is considered the responsible party for legal and ethical performance of the project.

**SECTION II: FUNDING AND DISCLOSURE**
1. Check all of the appropriate boxes for funding sources for this research, including pending funding source(s) (Choose one): If other: NA Additional: NA
* Principal Investigator's own Funding: NA
Funding Source: None
Contract or Grant No.: NA
Contract or Grant Title: NA
2. Do any of the researchers (principal investigator, co-principal investigators, or associated researchers) have any financial or commercial interest in the research? For each researcher, please specify their financial or commercial interest. No
3. Will this research lead to a commercial product? What is the product? Who will have commercial control over this product? How will potential subjects be informed of the development of this commercial product? No

**SECTION III: SUMMARY INFORMATION**

1. Will you perform medical procedures as part of this research proposal? No
2. Locations where research is to be conducted:
ISU Campus (Pocatello)
ISU Off-campus site (specify location) NA
Other site (non-ISU) (specify location) Participant's home, school and/or Charles Cole Memorial Hospital, Genesee, PA
3. Lay Language Summary:

Please provide a summary statement of the proposed research in non-technical language that can be understood by nonscientific readers. Include: (1) a brief statement of the problem and related theory supporting the intent of the research, and (2) a brief but specific description of the procedures involving human subjects. Attach additional pages as necessary.

Background:

Swallowing is a complex act that is subject to the effects of maturation. Individuals begin life with a mandatory tongue thrust posture during swallowing as a result of the mechanical processes involved in nursing. As the child matures, the swallow matures as well, resulting in a swallow pattern that no longer includes propelling the tongue forward. Some people do not outgrow this pattern, which is called a "tongue thrusting" pattern. The results of tongue thrust include cosmetic problems, since chronic tongue thrusting will alter the structure of the dental arch, cause a high palate (roof of mouth), and can result in problems with swallowing later in life. Treatment of tongue thrust involves a series of activities designed to retrain the swallow patterns to a more mature swallow. The present study examines one task (the Slurp Swallow) to determine in training using this method results in tongue strengthening. Subjects will be assessed for tongue thrust using a standard clinical instrument (the ISU Tongue Thrust Protocol), which involves observing a participant during several different acts of chewing and swallowing a triscuit cracker and swallowing water. Subjects who consent to participate will complete a health questionnaire. Subsequently, subjects will be asked to compress the bulb of the Iowa Oral Pressure instrument, a standard clinical tool for assessing oral muscle force. Tongue strength and lip strength will be measured, and the subject will be asked to produce a sustained "ah" as a control measure. Two sessions of baseline measures alone will be taken, and then 10 sessions of treatment will ensue. IOPI and vowel measures will be taken at each session prior to and after treatment. Two weeks after the 10 session treatment period subjects will be examined using IOPI one last time to determine the level of retention of muscle change. At that time the subject will also produce a sustained "ah" as a repeat of the control measure.

Treatment sessions will consist of asking the subject to elevate the tongue to the roof of the mouth after a small amount of water is squirted into the subject's mouth. The subject will be asked to push the tongue to the roof of the mouth and then pull the tongue back with forceful "slurping" effort. This will be interspersed with game activities for motivation. The task will be repeated 50 times per session. Subjects will get homework to do between sessions. This study seeks to replicate and expand upon previous research conducted by Alixandrea Buchanan (2007) at ISU, to further add to body of evidence regarding the slurp swallow and treatment of tongue thrust. The research hypothesis of the Buchanan study was supported by the results of three of the four participants. These early data that support the use of the slurp swallow exercise in tongue thrust correction programs were provided from that prior study (Buchanan, 2007).

**SECTION IV: PROTOCOL SUMMARY**

1. Renewal Application Complete renewal form if renewing active approved protocol.
2. If proposal is expedited, PI must choose one category (Choose one from dropdown):
   Consult webpage for choosing which category is appropriate for your research.
   www.isu.edu/research/hsc_forms/expeditedcategories5-07.pdf

3. Purpose of the Study: The purpose of the proposed study is to examine the effect of the "slurp swallow" tongue thrust treatment activity on muscle force. The study will enroll a total of 12 subjects, completed by students in speech-language pathology at Idaho State University. Currently, there are three students prepared to begin their thesis research (Rachel Durrant, Misty Torrey, Amy Dunn), and they will have 4 participants each (total of 12 participants).
4. The present proposal is requesting permission for Rachel Durrant, Misty Torrey and Amy Dunn to engage in the proposed research.
5. This study will replicate and build upon the study conducted by Alixandrea Buchanan (2007) and provide additional information regarding efficacy of oromyofunctional exercises, specifically the "Slurp Swallow." The purpose of Buchanan's (2007) study was to determine if 10 treatment sessions utilizing the slurp swallow would increase tongue tip and dorsum strength. Tongue strength was measured using the Iowa Oral Performance Instrument (Breakthrough Inc., Oakdale, IA; Model 1.5). In addition to data collected using the IOPI, this study seeks to expand upon the data collected by Buchanan by including additional tongue and lip placements. The research hypothesis of the Buchanan study was supported for three out of the four participants. Her findings indicated that the slurp swallow was effective in increasing lingual force. The subsequent two studies (Durrant; Torrey) will add 8 more subjects to the pool, increasing our ability to generalize results to the population. This activity is a standard clinical practice for treatment of tongue thrust (Pierce, 2002).
6. Pierce, R. (2002). Swallow Right, 2e.. Austin, TX: Pro-Ed Publishers.
7. Background: When the tongue exerts excessive pressure against the teeth at rest and during swallowing it is considered to be an orofacial myofunctional disorder called tongue thrust. Tongue thrust causes improper alignment of the teeth, abnormal swallowing patterns, and speech articulation errors (Seikel, King, & Drumright, 2010). The efficacy of oromyofunctional therapy programs to provide long-term correction of tongue thrust patterns has been documented in the literature. However, there is little research, currently, that investigates the efficacy of specific therapy exercises.
Seikel, J. A., King, D. W., & Drumright, D. G. (2010). Anatomy & Physiology for speech, language, and hearing. Clifton Park, NY: Delmar Cengage Learning.
8. Number of Subjects: The total number of subjects in the study will be 12.
9. Inclusion/Exclusion Criteria: The sample for the slurp swallow study will consist of 4 individuals from Potter County, Pennsylvania between 5 and 50 years of age who have demonstrated tongue thrust during swallow. Another 4 subjects will be recruited from the Idaho State University Speech and Hearing Clinic in Pocatello. Ultimately another 4 subjects will be recruited when another researcher is recruited for the study: Location of that research is yet to be determined, and will be subject to approval by the Idaho State University Institutional Review Board prior to initiating any research not approved specifically through this proposal.
10. Participants will be pre-identified as having tongue thrust by licensed speech-language pathologists or orthodontists. To be included in the study the individuals must demonstrate visible tongue protrusion during swallow and at least one of the following: excessive use of labial musculature, spillage during water and food swallows, lack of masseter contraction, or significant food residue in the oral cavity after swallowing. The above are all indications of tongue thrust. In addition, the individuals will not be

considered eligible for the study if they have received prior treatment for tongue thrust or have received any special education services other than speech and language services. The researcher will determine if the subject meets the inclusion and exclusion criteria. Because wheat crackers are used for assessment, subjects will be asked prior to assessment concerning wheat intolerance. If the subject has wheat intolerance, a gluten-free cracker will be used to replace the Triscuit cracker.
In the event that children are recruited, the parent or guardian will sign consent form (attached) that permits participation prior to initiating the study. If adults are not competent to give consent for participation in the study they will not be recruited into the study.
11. Vulnerable Subjects: There will be children under the age of 18 years. Children under the age of 18 are critical to include in the study because tongue thrust is typically seen in children and it is important to gather information concerning the efficacy of specific exercises in the treatment of tongue thrust. Permission will be sought from a parent or guardian prior to beginning the study.
12. Method of Subject Identification and Recruitment: Subjects will be recruited through personal contacts with individuals known to the subjects, as well as through contact with orthodontists and speech-language pathologists (SLPs). Subjects will also be recruited from the caseload of SLPs in the ISU Speech and Hearing Clinic in Pocatello, as well as from the caseload of SLPs in the Potter School for Children, in Ulysses, PA. Area orthodontists and SLPs will be contacted at both locales and provided recruitment fliers to be given to potential participants. These fliers will allow potential participants to make contact with the investigators, should they wish to. It will be obvious from the materials that no negative consequences will occur because of deciding not to participate and this will be emphasized during discussion with potential participants. Attached is a recruitment flyer that will be distributed as appropriate by referring speech-language pathologists to potential participants.
13. Methods and Procedures Applied to Human Subjects: Following consent to participate and completion of the health survey, participants will be seated at a table in a comfortable environment. At the initial session the researcher will assess the participant for tongue thrust, using the ISU Tongue Thrust Protocol (attached). This is a standard clinical instrument used for this purpose at ISU. The task involves assessment of muscle tone and oral motor function, and involves drinking sips of water and eating a triscuit cracker while swallow patterns are observed. Following this the experimenter will introduce the IOPI instrument to the participant, demonstrating the measurement procedures. The participant will be asked to compress the IOPI bulb with his/her tongue dorsum (back of tongue), tip (front of tongue) and lips 3 times, and the peak force will be recorded. Then the participant will be asked to sustain the vowel /a/ 3 times as long as possible for three trials as a control measure. The first two sessions will be for baseline measure purposes only, with no treatment. For the third and subsequent sessions the participant will be tested using IOPI and sustained vowel before and after treatment. Treatment consists of the slurp swallow activity. In this activity, a small amount of water is squirted into the participant's mouth from a water bottle, and then the participant is asked to put his/her tongue tip on the roof of the mouth and pull the tongue posteriorly with force, making a slurping noise. This is repeated 50 times during the session, with times between trials for games and other activities as motivation. Participants will be

given instructions and homework sheets to take with them, which will help document at-home work on the skill. A total of 10 treatment sessions will ensue. Subjects will be tested again 2 weeks following the final treatment day to determine whether the effect seen in treatment is sustained. Follow-up testing will involve use of the IOPI (as above) and performance of the sustained "ah" (as above).

14. This is a single-subjects treatment study, with each subject serving as his/her own control. Statistical significance for each subject will be determined using a 2-standard deviation band method (Nourbakhsh & Ottenbacher, 1994). The standard deviation of the baseline data is calculated, and a line is drawn 2 standard deviations above and below the baseline mean. If more than two treatment points are outside this band it is considered significant, because there is only a 5/100 chance of this occurring.

15. At the Pennsylvania site, a majority of the administration will take place in the speech therapy department of Charles Cole Memorial Hospital in Coudersport, PA under the supervision of Amy Greene, M.S., CCC-SLP or the speech therapy classroom at Northern Potter Children's School in Ulysses, PA (see letters of agreement, attached). The remaining administrations will take place in the participant's home or other mutually-agreed upon location. In Idaho, the treatments will occur in the speech therapy classroom of the individual subject's home school, the Idaho State University Speech and Hearing Clinic, the participant's home or other mutually-agreed upon location. The instrument will be administered in person in a one-on-one setting. The form will be coded, and the relationship between coded form and name will be separated. The information linking coded number and name will be stored in a file cabinet in a locked office at Charles Cole Memorial Hospital or the Idaho State University CSED building, and will be destroyed upon completion of analysis and publication of data. The duration for each therapy session will be approximately 60 minutes over 10 sessions.

Nourbakhsh, M. R. & Ottenbacher, K. J. (1994). The Statistical Analysis of Single-Subject Data: Comparative Examination. Physical Therapy, 74, 768-776.

16. For Research Involving Surveys, Questionnaires, etc.:

17. FDA Approval: N/A

18. Data Collection, Storage, Confidentiality and Data Disposition: The data will be recorded on a paper protocol and on a computer. Observational data will be on the attached protocol, which will be stored in a binder in a locked file cabinet The form will be coded, and the relationship between coded form and name will be separated. The information linking coded number and name will be stored in a file cabinet in a locked office at Charles Cole Memorial Hospital, and will be destroyed upon completion of analysis and publication of data. In Pocatello, the subject information will be stored in a file cabinet in a locked faculty office, and destroyed upon completion of data analysis.

19. Potential Risks and/or Discomforts: It is important to note that both the treatment and the measurement device are standard clinical procedures in speech-language pathology. There are minimal potential risks associated with participation in this study. These include feelings of embarrassment or discomfort as the participant practices the exercises and mild fatigue and/or mild soreness of the muscles in the mouth. There is also a risk of aspiration which may cause the subject to cough. Participants and/or their parents or guardians will be informed of these risks verbally and in a written format within the informed consent material. They will be informed of their right to withdraw from the study at any time with no penalty. There is a risk of accidental loss of confidentiality.

There is risk that an individual with wheat or gluten intolerance could have an adverse reaction to the use of Triscuit cracker during assessment. Individuals and their guardians (where appropriate) will be informed of the use of wheat-laden food, and that will be replaced by a gluten free product if gluten or wheat-based products are a problem for the individual. Alternately, the individual may opt out of the study.
20. Risk Classification: Minimal
21. Minimizing Risks: The few potential risks can be minimized by letting the participants know they can stop at any time they feel uncomfortable. By separating names and data and keeping information in a secure location the risk of accidental loss of confidentiality can be minimized. Gluten-free products will be offered as an alternative to wheat-based products, should someone have an allergy that precludes use of the cracker.
22. Potential Benefits: While it is not probable that participation in this study will completely remediate tongue thrust behaviors in any individuals, there are some possible benefits. Parents/guardians and participants will be given this information within the informed consent materials and these points will be discussed prior to beginning the study. Not all participants will experience the same level of benefit. Benefits include possible increased strength in the tongue, which may help with swallowing. A second benefit is the potential for increased evidence base regarding the effectiveness of the slurp swallow exercise in the field of speech-language pathology.
23. Therapeutic Alternatives: Subjects can receive alternate tongue thrust therapy if they wish, through providers within the community with the understanding that they will be responsible for any associated fees.
24. Risk/Benefit Ratio: The research poses no real risks to the participants as none of the procedures involved is invasive in nature. The results of the research could eventually provide better information in diagnosing and understanding swallowing disorders.
25. Payment for Participation: No payment is planned for participants.
26. Financial Obligations of the Subjects: The subjects will be under not financial obligations. All costs of materials and supplies necessary for the procedures will be absorbed by the researchers.
27. Emergency Care and Compensation for Research-Related Injury: There is minimal to no risk from the procedures. Researchers will not be held financially responsible for any injuries incurred during the research process.
28. Capacity to Consent: All individuals will have the capacity to consent. In the case of minors, parents or legal guardians will be asked to provide consent.
29. Personnel Inviting Participation: Only the principal investigator, Dr. Tony Seikel, and co-investigators, will be authorized to solicit participants' consent and describe the research to participants. When soliciting participants, the investigators will say the following: "I am doing a study looking at the structure and function of swallowing. The study is non-invasive and I will be using various instruments throughout to gather information as you drink water and eat a cracker or cookie. If you are allergic to wheat products I can provide a gluten-free cookie or cracker. You will be asked to complete 10 therapy sessions consisting of 50 repetitions of a single exercise. Should you feel uncomfortable or choose to discontinue participation at any time, you may do so. You don't have to participate in the study, and deciding not to will not have any impact on any other services you receive. Would you be willing to participate?"

30. Process of Consent: Individuals will be given a flier by their orthodontist or SLP (attached). If he or she wishes to consider participation they will contact the experimenters. During the consent process subjects will be given a description of the study (attached). The study will be explained to them, including procedures and approximate time commitment, and their participation shall be considered consent to participate.
31. Comprehension of the information provided: Subjects will by definition be normally functioning children and adults, with the exception of having been identified as having tongue thrust. Children's parents or guardians will have provided permission for participation. Both children and their guardians will be told that they can terminate participation at any time.
32. Information Withheld From Subjects: No
33. Consent/Assent Forms: Specify the form(s) that will be used among the following@

Youth Assent Form (ages 13-18) Child Assent Form (ages 7-12)
Adult Consent Form

Explain why these are the appropriate forms for this research: The study is looking at therapeutic benefit across various age groups and therefore, all consent forms will be necessary in the study but will be administered appropriately based on participant's age.

If research involves Investigational Drug and Medical Devices, complete HS-1 drug and device sections.

Idaho State University
Human Subjects Committee
Mail Stop 8130

HS-1 Rev 6/2008

**REQUESTING VOLUNTEERS FOR A STUDY OF TONGUE THRUST**

Dear Parents/Guardians,

My name is Misty Torrey. I am attending Idaho State University as a Graduate Student in the Speech-Language Pathology Program. I am working on a thesis that is exploring the effectiveness of a tongue strengthening exercise called the Slurp Swallow. I am gathering this information on children and adults who exhibit tongue thrusting behaviors with no co-existing conditions. The study will develop data that can be used in a larger study examining the effects of tongue thrust in an aging population.

**I am asking for volunteers to be participants in my study.** Each participant will practice the exercise during each session. I will measure tongue strength before and after each block of practice using the Iowa Oral Pressure Instrument (IOPI), which is a standard clinical measurement device in speech pathology. The instrument should not cause the subject any discomfort. The IPOI is used by placing a small plastic bulb on the roof of the mouth and having the participant apply pressure using their tongue. The first session will take approximately 30-60 minutes and will include a parent interview and a swallow evaluation. If a participant is wheat or gluten intolerant, we can substitute a gluten-free product during the assessment. Subsequent sessions will take approximately 10 to 20 minutes.

Please consider allowing your child to participate in the study or participating yourself if you think you have tongue thrust. Again, the participants I need should be within the **ages of 5-50 years**. Due to the age requirement, I will need parent's consent to allow their child to participate. If at any time you choose not to participate, you do not have to continue. If you would like more information about what we will be doing, please call me. If you would like your child to participate in the study, or if you think you have tongue thrust and would like to participate, please call me at the above phone number, or email me at durrrach@isu.edu and I will contact you to schedule a time. Thank you for your help!

---

____ I am interested in participating. Please contact me with more information.

Name: _____

Please contact me at (home)_____ or (cell) _____.

# Idaho State University
# Human Subjects Committee
# Informed Consent Form for Non-Medical Research

**CONSENT TO PARTICIPATE IN RESEARCH: Parent or Guardian permitting Child to Participate**

## The Treatment Efficacy of Oromyofunctional Exercises (Slurp Swallow Exercise) in Strengthening the Tongue in Persons with Tongue Thrust

We are asking for your child to be in a research study.

Your child does not have to be in this study.

If you say yes, your child may quit the study at any time.

Please take as much time as you want to make your decision.

We are asking that your child be permitted to participate in a research study conducted by Tony Seikel, Ph.D., of Communication Sciences & Disorders, and Education of the Deaf, Idaho State University (208-282-4196). The co-investigator for this study is Misty Torrey. Data from this study will be reported in this student's Master's thesis. Your child has been asked to participate in this research because he or she has been identified as having a condition known as tongue thrust.

Four subjects will be used for this specific study, and 12 subjects will be included in the total study. You and your child's participation in this research project is voluntary. You should read the information below, and ask questions about anything you do not understand, before deciding whether or not to participate.

### 1. **PURPOSE OF THE STUDY**

This study is designed to examine the effectiveness of one form of treatment for tongue thrust.

### 2. **PROCEDURES**

If you allow your child to participate in this study, we would ask your child to do the following things:

a. Your child will be given a brief test in which you drink, eat and swallow small amounts of water and a cracker to determine your swallowing pattern. If it is shown that you (or your child) have tongue thrust we can continue with the study procedure. If you have an allergy to wheat products a gluten-free food will be provided.

b. Your child will be asked to press down on a nylon bulb several times with his or her tongue and lips in order to determine the strength of the tongue and lips. Then your child will be asked to say "ah" as long as he or she can three times.

c. After that your child will be asked to press his or her tongue to the roof of the mouth and then pull the tongue back in your child's mouth, making a slurping sound. A small amount of water will be squirted onto your child's tongue before doing this exercise. This will be repeated a number of times. The strength measures and vowel production will be performed again at the end of the session. There will be 10 consecutive sessions in the study.
d. The total time for the first session should be approximately 30 minutes but would not exceed 60 minutes for your child's participation.
e. Subsequent sessions will take approximately 10-20 minutes.
f. The study will be performed at the ISU Speech and Hearing Center in Pocatello, Charles Cole Memorial Hospital, Northern Potter Children's School, your child's home school, your home, or other location of your choosing.

3. **POTENTIAL RISKS AND DISCOMFORTS**

If your child is diabetic we will provide foods with artificial sweetener. If your child is allergic to the wheat we can provide a gluten-free alternative, or you may elect not to allow your child to participate in the study. Your child might feel embarrassment by the attention to eating habits. Your child might breathe in some of the food or liquid during the testing, which would make him or her cough. You should know that you and your child are free to discontinue the study at any time.

4. **ANTICIPATED BENEFITS TO SUBJECTS**

This study will likely have no direct benefit to an individual, although some improvement in tongue thrusting might be seen.

5. **ANTICIPATED BENEFITS TO SOCIETY**

This study will help researchers determine the effectiveness of tongue thrust therapy.

6. **ALTERNATIVES TO PARTICIPATION**

Participation is voluntary, and you may end participation at any time. There are no other alternatives to participation.

7. **PAYMENT FOR PARTICIPATION**

There is no payment offered or available for participation.

8. **FINANCIAL OBLIGATIONS**

You will not be asked to pay for any of these procedures.

9. **PRIVACY AND CONFIDENTIALITY**

The only people who will know that your child is a research subject are members of the research team. No information about you, or provided by you during the research, will be

disclosed to others without your written permission, except (a) if necessary to protect our rights or welfare (for example, if you are injured), or (b) if required by law.

When the results of the research are published or discussed in conferences, no information will be included that would reveal your child's identity. Data will be stored in a file cabinet in a locked office, and will be separated from your name so that no one could identify your data individually. Contact data will be destroyed seven years after publication of the research findings.

10. **PARTICIPATION AND WITHDRAWAL**
Your child's participation in this research is VOLUNTARY. If you or your child choose not to participate, that will not affect your relationship with Idaho State University, or your right to receive services in any clinics or by healthcare providers. **If you decide to participate, you or your child are free to withdraw consent and discontinue participation at any time without penalty. Participation will in no way affect your ability to receive services at Idaho State University, Charles Cole Memorial Hospital, or Northern Potter Children's School.**

11. **WITHDRAWAL OF PARTICIPATION BY THE INVESTIGATOR**
The investigator may withdraw your child from participating in the research if circumstances arise which warrant doing so. If your child experiences any of the following (coughing or hoarse voice after swallowing) you may have to drop out of the research, even if you would like to continue. The investigator (Tony Seikel) will make the decision and let you know if it is not possible for your child to continue. The decision may be made either to protect your child's health and welfare, or because it is part of the research plan that people who develop certain conditions may not continue to participate. Withdrawal will not affect your relationship with Idaho State University, or the facility from which you are receiving services. Likewise, withdrawal will have no effect on your right to receive services from other clinics or healthcare providers.

12. **IDENTIFICATION OF INVESTIGATORS**
In the event of a research related injury or if you experience an adverse reaction, please immediately contact one of the investigators listed below. If you have any questions about the research, please feel free to contact Tony Seikel at 208-282-4196 or seikel@isu.edu at any time.

13. **RIGHTS OF RESEARCH SUBJECTS**
You or your child may withdraw consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have any questions regarding your rights as a research subject, you may contact the Human Subjects Committee office at 282-2179 or by writing to the Human Subjects Committee at Idaho State University, Mail Stop 8130, Pocatello, ID 83209.

_____ _____

**Your Name (please print)** **Your Child's Name (Please print)**

**_____** **_____**

**Your Signature** **Date**

**Youth Assent Form (Ages 13-17)** **Child Assent Form (Ages 5 -12)**

## The Treatment Efficacy of Oromyofunctional Exercise (Slurp Swallow Exercise) in Strengthening the Tongue in Persons with Tongue Thrust

1. My name is Misty Torrey

2. We are asking you to take part in a research study because we are trying to learn more about how to treat problems related to tongue thrust.

3. If you agree to be in this study you will first be asked to chew a cracker, drink some water, and allow me to look at your facial muscles as you swallow. I will ask to look in your mouth as you swallow, and will pull your lip down once or twice to see your tongue.

After that, you will be asked to bite down while I measure muscle strength, and I will ask you to say "ah" three times. You will then be asked to do some exercises that involve putting a little water on your tongue, and then putting your tongue on the roof of your mouth and moving it toward the back of your mouth. After practicing this several times we will make the measures again. We will have 10 sessions in which we do these exercises and take these measures. We'll ask you to do the same exercises at home as well.

4. The only real risk is if you were to get some water down your throat it might make you cough. If you are allergic to wheat, we can give you a cracker or cookie that does not have wheat in it.

5. This study will help us Figure out if the type of activities we do helps people swallow better.

6. We have already received permission from your parent(s) for you to participate in this research. Even though your parent(s) have given permission, you still can decide for yourself if you want to participate.

7. If you don't want to be in this study, you don't have to participate. Remember, being in this study is up to you and no one will be upset if you don't want to participate or even if you change your mind later and want to stop. Being in this study is not required, and you can still come to speech therapy if you don't join the study.

8. You can ask any questions that you have about the study. If you have a question that you didn't think of now, you can ask me later.

_____

**Your Name (please print)**

_____ _____

**Your Signature** **Date**

_____ _____

**Signature of Witness** **Date**

Appendix C: Adult Consent Form

# Idaho State University
# Human Subjects Committee
# Informed Consent Form for Non-Medical Research

**CONSENT TO PARTICIPATE IN RESEARCH: Adult participant**

The Treatment Efficacy of Oromyofunctional Exercises (Slurp Swallow Exercise) in Strengthening the Tongue in Persons with Tongue Thrust

You are asked to participate in a research study conducted by Tony Seikel, Ph.D., of Communication Sciences & Disorders, and Education of the Deaf, Idaho State University (208-282-4196). The co-investigator for this study is Misty Torrey. Data from this study will be reported in this student's Master's thesis. You have been asked to participate in this research because you have been identified as having a condition known as tongue thrust.
Four subjects will be used for this specific study, and 12 subjects will be included in the total study. Your participation in this research project is voluntary. You should read the information below, and ask questions about anything you do not understand, before deciding whether or not to participate.

1. **PURPOSE OF THE STUDY**

This study is designed to examine the effectiveness of one form of treatment for tongue thrust.

2. **PROCEDURES**
If you volunteer to participate in this study, we would ask you to do the following things:

a. You will be given a brief test in which you drink, eat and swallow small amounts of water and a cracker to determine your swallowing pattern. If it is shown that you have tongue thrust we can continue with the study procedure. If you have an allergy to wheat products a gluten-free food will be provided.
b. You will be asked to press down on a nylon bulb several times with your tongue and your lips in order to determine the strength of your tongue and lips. Then you will be asked to say "ah" as long as you can three times.
c. After that you will be asked to press your tongue to the roof of your mouth and then pull your tongue back in your mouth, making a slurping sound. A small amount of water will be squirted onto your tongue before doing this exercise. This will be repeated a number of times. The strength measures and vowel production will be performed again at the end of the session. There will be 10 consecutive sessions in the study.
d. The total time for the first session should be approximately 30 minutes but would not exceed 60 minutes for your participation.
e. Subsequent sessions will take approximately 10-20 minutes.

f. The study will be performed at the ISU Speech and Hearing Center in Pocatello, Charles Cole Memorial Hospital, Northern Potter Children's School, your home or other location of your choosing.

3. **POTENTIAL RISKS AND DISCOMFORTS**

If you are diabetic we will provide foods with artificial sweetener. If you are allergic to the wheat we can provide a gluten-free alternative, or you may elect not to participate in the study. You might feel embarrassment by the attention to your eating habits. You might breathe in some of the food or liquid during the testing, which would make you cough. You should know that you are free to discontinue the study at any time.

4. **ANTICIPATED BENEFITS TO SUBJECTS**

This study will likely have no direct benefit to an individual, although some improvement in tongue thrusting might be seen.

5. **ANTICIPATED BENEFITS TO SOCIETY**

This study will help researchers determine the effectiveness of tongue thrust therapy.

6. **ALTERNATIVES TO PARTICIPATION**

Participation is voluntary, and you may end participation at any time. There are no other alternatives to participation.

7. **PAYMENT FOR PARTICIPATION**

There is no payment offered or available for participation.

8. **FINANCIAL OBLIGATIONS**

You will not be asked to pay for any of these procedures.

9. **PRIVACY AND CONFIDENTIALITY**

The only people who will know that you are a research subject are members of the research team. No information about you, or provided by you during the research, will be disclosed to others without your written permission, except (a) if necessary to protect our rights or welfare (for example, if you are injured), or (b) if required by law.

When the results of the research are published or discussed in conferences, no information will be included that would reveal your identity. Data will be stored in a file cabinet in a locked office, and will be separated from your name so that no one could identify your data individually. Contact data will be destroyed seven years after publication of the research findings.

10. **PARTICIPATION AND WITHDRAWAL**

Your participation in this research is VOLUNTARY. If you choose not to participate, that will not affect your relationship with Idaho State University, or your right to receive services in any clinics or by healthcare providers. **If you decide to participate, you are free to withdraw your consent and discontinue participation at any time without penalty. Your participation will in no way affect your ability to receive services at Idaho State University, Charles Cole Memorial Hospital, or Northern Potter Children's School.**

11. **WITHDRAWAL OF PARTICIPATION BY THE INVESTIGATOR**
The investigator may withdraw you from participating in the research if circumstances arise which warrant doing so. If you experience any of the following (coughing or hoarse voice after swallowing) you may have to drop out of the research, even if you would like to continue. The investigator (Tony Seikel) will make the decision and let you know if it is not possible for you to continue. The decision may be made either to protect your health and welfare, or because it is part of the research plan that people who develop certain conditions may not continue to participate. Withdrawal will not affect your relationship with Idaho State University, or the facility from which you are receiving services. Likewise, withdrawal will have no effect on your right to receive services from other clinics or healthcare providers.

12. **IDENTIFICATION OF INVESTIGATORS**
In the event of a research related injury or if you experience an adverse reaction, please immediately contact one of the investigators listed below. If you have any questions about the research, please feel free to contact Tony Seikel at 208-282-4196 or seikel@isu.edu at any time.

13. **RIGHTS OF RESEARCH SUBJECTS**
You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have any questions regarding your rights as a research subject, you may contact the Human Subjects Committee office at 282-2179 or by writing to the Human Subjects Committee at Idaho State University, Mail Stop 8130, Pocatello, ID 83209.

_____
**Your Name (please print)**

_____ _____
**Your Signature** **Date**

Appendix D: Child Assent Form

# Idaho State University
# Human Subjects Committee
# Assent Form

☐ **Child Assent Form (Ages 5 -12)**

## The Treatment Efficacy of Oromyofunctional Exercise (Slurp Swallow Exercise) in Strengthening the Tongue in Persons with Tongue Thrust

1. My name is Misty Torrey

2. We are asking you to take part in a research study because we are trying to learn more about how to treat problems related to tongue thrust.

3. If you agree to be in this study you will first be asked to chew a cracker, drink some water, and allow me to look at your facial muscles as you swallow. I will ask to look in your mouth as you swallow, and will pull your lip down once or twice to see your tongue.

After that, you will be asked to bite down while I measure muscle strength, and I will ask you to say "ah" three times. You will then be asked to do some exercises that involve putting a little water on your tongue, and then putting your tongue on the roof of your mouth and moving it toward the back of your mouth. After practicing this several times we will make the measures again. We will have 10 sessions in which we do these exercises and take these measures. We'll ask you to do the same exercises at home as well.

4. The only real risk is if you were to get some water down your throat it might make you cough. If you are allergic to wheat, we can give you a cracker or cookie that does not have wheat in it.

5. This study will help us Figure out if the type of activities we do helps people swallow better.

6. We have already received permission from your parent(s) for you to participate in this research. Even though your parent(s) have given permission, you still can decide for yourself if you want to participate.

7. If you don't want to be in this study, you don't have to participate. Remember, being in this study is up to you and no one will be upset if you don't want to participate or even if you change your mind later and want to stop. Being in this study is not required, and you can still come to speech therapy if you don't join the study.

8. You can ask any questions that you have about the study. If you have a question that you didn't think of now, you can ask me later.

_____

**Your Name (please print)**

_____ _____

**Your Signature** **Date**

_____ _____

**Signature of Witness** **Date**

Appendix E: Informed Consent-Parent/Guardian Permission for Child to Participate

## Idaho State University
## Human Subjects Committee
## Informed Consent Form for Non-Medical Research

**CONSENT TO PARTICIPATE IN RESEARCH: Parent or Guardian permitting Child to Participate**

The Treatment Efficacy of Oromyofunctional Exercises (Slurp Swallow Exercise) in Strengthening the Tongue in Persons with Tongue Thrust

| |
|---|
| We are asking for your child to be in a research study. |
| Your child does not have to be in this study. |
| If you say yes, your child may quit the study at any time. |
| Please take as much time as you want to make your decision. |

We are asking that your child be permitted to participate in a research study conducted by Tony Seikel, Ph.D., of Communication Sciences & Disorders, and Education of the Deaf, Idaho State University (208-282-4196). The co-investigator for this study is Misty Torrey. Data from this study will be reported in this student's Master's thesis. Your child has been asked to participate in this research because he or she has been identified as having a condition known as tongue thrust.

Four subjects will be used for this specific study, and 12 subjects will be included in the total study. You and your child's participation in this research project is voluntary. You should read the information below, and ask questions about anything you do not understand, before deciding whether or not to participate.

1. **PURPOSE OF THE STUDY**

This study is designed to examine the effectiveness of one form of treatment for tongue thrust.

2. **PROCEDURES**

If you allow your child to participate in this study, we would ask your child to do the following things:
a. Your child will be given a brief test in which you drink, eat and swallow small amounts of water and a cracker to determine your swallowing pattern. If it is shown that

you (or your child) have tongue thrust we can continue with the study procedure. If you have an allergy to wheat products a gluten-free food will be provided.
b. Your child will be asked to press down on a nylon bulb several times with his or her tongue and lips in order to determine the strength of the tongue and lips. Then your child will be asked to say "ah" as long as he or she can three times.

c. After that your child will be asked to press his or her tongue to the roof of the mouth and then pull the tongue back in your child's mouth, making a slurping sound. A small amount of water will be squirted onto your child's tongue before doing this exercise. This will be repeated a number of times. The strength measures and vowel production will be performed again at the end of the session. There will be 10 consecutive sessions in the study.
d. The total time for the first session should be approximately 30 minutes but would not exceed 60 minutes for your child's participation.
e. Subsequent sessions will take approximately 10-20 minutes.
f. The study will be performed at the ISU Speech and Hearing Center in Pocatello, Charles Cole Memorial Hospital, Northern Potter Children's School, your child's home school, your home, or other location of your choosing.

3. **POTENTIAL RISKS AND DISCOMFORTS**

If your child is diabetic we will provide foods with artificial sweetener. If your child is allergic to the wheat we can provide a gluten-free alternative, or you may elect not to allow your child to participate in the study. Your child might feel embarrassment by the attention to eating habits. Your child might breathe in some of the food or liquid during the testing, which would make him or her cough. You should know that you and your child are free to discontinue the study at any time.

4. **ANTICIPATED BENEFITS TO SUBJECTS**

This study will likely have no direct benefit to an individual, although some improvement in tongue thrusting might be seen.

5. **ANTICIPATED BENEFITS TO SOCIETY**

This study will help researchers determine the effectiveness of tongue thrust therapy.

6. **ALTERNATIVES TO PARTICIPATION**

Participation is voluntary, and you may end participation at any time. There are no other alternatives to participation.

7. **PAYMENT FOR PARTICIPATION**

There is no payment offered or available for participation.

8. **FINANCIAL OBLIGATIONS**

You will not be asked to pay for any of these procedures.

9. **PRIVACY AND CONFIDENTIALITY**

The only people who will know that your child is a research subject are members of the research team. No information about you, or provided by you during the research, will be disclosed to others without your written permission, except (a) if necessary to protect our rights or welfare (for example, if you are injured), or (b) if required by law.

When the results of the research are published or discussed in conferences, no information will be included that would reveal your child's identity. Data will be stored in a file cabinet in a locked office, and will be separated from your name so that no one could identify your data individually. Contact data will be destroyed seven years after publication of the research findings.

10. **PARTICIPATION AND WITHDRAWAL**

Your child's participation in this research is VOLUNTARY. If you or your child chooses not to participate, that will not affect your relationship with Idaho State University, or your right to receive services in any clinics or by healthcare providers. **If you decide to participate, you or your child are free to withdraw consent and discontinue participation at any time without penalty. Participation will in no way affect your ability to receive services at Idaho State University, Charles Cole Memorial Hospital, or Northern Potter Children's School.**

11. **WITHDRAWAL OF PARTICIPATION BY THE INVESTIGATOR**

The investigator may withdraw your child from participating in the research if circumstances arise which warrant doing so. If your child experiences any of the following (coughing or hoarse voice after swallowing) you may have to drop out of the research, even if you would like to continue. The investigator (Tony Seikel) will make the decision and let you know if it is not possible for your child to continue. The decision may be made either to protect your child's health and welfare, or because it is part of the research plan that people who develop certain conditions may not continue to participate. Withdrawal will not affect your relationship with Idaho State University, or the facility from which you are receiving services. Likewise, withdrawal will have no effect on your right to receive services from other clinics or healthcare providers.

12. **IDENTIFICATION OF INVESTIGATORS**

In the event of a research related injury or if you experience an adverse reaction, please immediately contact one of the investigators listed below. If you have any questions about the research, please feel free to contact Tony Seikel at 208-282-4196 or seikel@isu.edu at any time.

13. **RIGHTS OF RESEARCH SUBJECTS**

You or your child may withdraw consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have any questions regarding your rights as a research subject, you may contact the Human Subjects Committee office at 282-2179 or

by writing to the Human Subjects Committee at Idaho State University, Mail Stop 8130, Pocatello, ID 83209.

| | |
|---|---|
| **Your Name (please print)** | **Your Child's Name (Please print)** |
| **Your Signature** | **Date** |

Appendix F: Permission to Recruit Participants from Northern Potter School District

-------- Forwarded message ----------
From: **Graham, Scott**
Date: Thu, Feb 14, 2013 at 12:22 PM
Subject: Re: thesis
To: Misty Torrey

Misty
I am fine with your request.
Scott

On Feb 14, 2013 12:17 PM, "Misty Torrey" wrote:
Mr. Morgan and Mr. Graham,

As you may know I am nearing the end of my three year graduate program. I am working towards a research thesis to test the efficacy of a specific oromyofunctional exercise on remediation of tongue thrust. I will be taking measurements, providing treatment and comparing the results of the measurements from each session. I am seeking at least 4 individuals with tongue thrust to participate. The therapy is non-intrusive, I have completed training regarding research ethics and the project will have approval of the Idaho State University Human Subjects Committee.

I would like to respectfully request your permission to contact the families of some of my students whom I suspect have tongue thrust, and request permission to complete the research here at Northern Potter. Given our rural location and the 10 consecutive week day therapy protocol, I am not sure I will be able to complete the therapy without taking a leave from work to allow for travel time. I have room in my schedule (as I can alter my internship requirements) to complete the short therapy sessions during my unpaid lunch period. I foresee that I can accommodate student schedules as well so they are not missing important class time.

This study will add to the growing body of evidence regarding oromyofunctional therapy, and contribute to data collected in a larger study by Tony Seikel, PhD, my adviser. There is also a growing body of evidence that oromyofunctional disorders impact articulation and it is well documented that they impact dentition. I believe completion of this type of research will contribute to our understanding of oromyofunctional treatment and may ultimately alter how we view articulation therapy.

I thank you for your time and consideration.

Sincerely,
Misty Torrey