THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF COMMUNICATION SCIENCES AND DISORDERS

RELIBILITY OF CLINICALLY AVAILABLE TOOLS FOR OROFACIAL SOMATOSENSORY TESTING

OLIVIA MILLER
SPRING 2016

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree in Communication Sciences and Disorders
with honors in Communication Sciences and Disorders

Reviewed and approved* by the following:

Nicole Etter
Assistant Professor of Communication Sciences and Disorders
Thesis Supervisor

Ingrid Blood
Professor of Communication Sciences and Disorders
Honors Adviser

* Signatures are on file in the Schreyer Honors College.

ABSTRACT

The purpose of this study was to assess the reliability of two clinically available tools for the use of orofacial somatosensory testing. With speech dysarthrias, speech language pathologists have customarily focused on the motor aspects of speech disorders with little clinical consideration of the importance of sensation. Somatosensory inputs have been shown to be necessary for achieving accurate speech production and perception. However, the devices available for orofacial somatosensory testing are those only accessible in laboratory settings and those that have not yet proven to be reliable. The two clinical measures in this study, tested in the lingual and labial regions, are two-point discrimination and Von Frey hair monofilaments. Four participants, selected from a healthy control population, completed three assessments: two-point discrimination, tactile detection and discrimination thresholds. Each participant returned for reliability testing between 11-17 days of initial testing. A descriptive analysis of the results was completed. For these participants, we found these two clinical devices to be reliable. These data will contribute to the larger sample pool for more formal statistical analyses.

TABLE OF CONTENTS

LIST OF FIGURES iv

LIST OF TABLES v

ACKNOWLEDGEMENTS vi

Chapter 1 Introduction 1

Chapter 2 Literature Review 3

- Oral Mechanism Examination 3
- Somatosensory Perception 4
- DIVA Model 5
- Devices Available 5
- Purpose of Study 7

Chapter 3 Methods 8

- Participants 8
- Testing Procedures 9
- Two-Point Discrimination Threshold Estimates 10
- Tactile Detection Threshold Estimates 10
- Tactile Discrimination Threshold Estimates 11
- Reliability Testing 11

Chapter 4 Results 13

- Two-Point Discrimination Thresholds 14
- Detection Threshold Estimates 17
- Discrimination Threshold Estimates 20

Chapter 5 Discussion/ Conclusion 23

- Reliability of Von Frey hair monofilaments 23
- Participant Perception 24
- Descriptive Analysis 25
- Additional Research of Sensory Functioning 25
- Conclusion 27

References 28

LIST OF FIGURES

Figure 1. Two-Point Discrimination Thresholds 15

Figure 2. Tactile Detection Threshold Estimates...18

Figure 3. Tactile Discrimination Threshold Estimates 21

LIST OF TABLES

Table 1. Participant Data..9

Table 2. Difference in Days between Testing..12

Table 3. Two Point Discrimination Data 16

Table 4. Tactile Detection Data 19

Table 5. Tactile Discrimination Data..22

ACKNOWLEDGEMENTS

I would like to thank my thesis supervisor, Dr. Nicole Etter, who has worked with me on this project since the beginning. I am grateful to have had her support and guidance throughout this process. I appreciate her willingness to answer the many questions I had while conducting research and writing my paper. I have greatly enjoyed working with her and attending her weekly lab meetings with other undergraduate and graduate students.

I would also like to thank Dr. Ingrid Blood, my honors adviser, for her encouragement throughout my undergraduate career. Dr. Blood was always available when I needed help, whether by email or by scheduling an appointment to talk.

Chapter 1

Introduction

Traditionally with speech dysarthrias, speech language pathologists have focused on the motor aspects of speech disorders. Somatosensory inputs, however, are important for achieving accurate speech perception and production. With therapeutic intervention, there is manipulation of a client's sensory environment in order to make changes in motor output. For example, a speech language pathologist may be working with a client on making the /l/ sound. In addition to auditory cues where the speech language pathologist may model how /l/ should sound, the speech language pathologist often gives somatosensory cues. In order to make the /l/ sound, the tongue needs to be pushed against the back of the front teeth. Feeling the tongue on the back of the teeth aids a client in understanding the placement of producing the /l/ sound. With decreased somatosensation, a client may find it difficult to execute the sound. Understanding the sensory aspect of speech disorders may aid clinicians in providing more tailored therapeutic goals. Unfortunately, the devices currently available are those that are only accessible in laboratory settings or that have not yet proven to be reliable. The purpose of this study is to determine the reliability of clinically available means of orofacial somatosensory testing.

The two clinical measures are two-point discrimination and Von Frey hair monofilaments for detection and discrimination of the lingual and labial regions. Two-point discrimination has been used in studies concerning the upper and lower extremities, sole of the foot, neck, hand, and back (Catley et al., 2013; Franco, P.G., Santos, K.B., & Rodacki, A.L.F., 2015; Han et al., 2015). Previous research shows Von Frey hairs to be reliable in testing of the fingers and feet, predominately in cases of leprosy and diabetes (Haloua, Sierevelt, & Theuvenet, 2011; Lavery et al., 2012; Santhanam, 2003).

Little research currently exists regarding the testing of somatosensory perception in the orofacial region. With somatosensation being tied closely to proper speech production, a client's somatosensory thresholds should be assessed. Before tools can be tested in a clinical population, however, they must first prove to be reliable in a healthy population.

Chapter 2

Literature Review

Oral Mechanism Examination

Speech language pathologists regularly perform examinations in order to evaluate patients and to grasp a better sense of a client's condition. An oral mechanism examination is a test used by speech language pathologists to evaluate the structure and function of the speech mechanism in order to assess the capability of the system. The system is observed during rest, sustained postures, movement, and reflexes (Duffy, 2005).

The test includes the examination of eight areas: facial status, lip functioning, jaw functioning, hard palate, tongue functioning, velopharyngeal functioning, status of dentition, and motor speech programming abilities. For facial status, the face is checked for signs of abnormality or asymmetry. The lips are monitored for asymmetrical movements and for repetitions that appear to be slow, dysrhythmic, or imprecise. The jaw's movements are watched for asymmetrical movements, limitations in range, and temporomandibular joint noise. Any unusual arch shape or tissue appearance in the hard palate is checked. For the tongue, its movements are looked at to determine whether there is an insufficient range and precision and whether the repetitions are too slow, dysrhythmic, or imprecise. Signs of hypernasal or hyponasal resonance are checked for velopharyngeal functioning. Status of dentition is determined by the examination of the teeth; abnormalities in alignment, condition of the upper/lower teeth, and evidence of gum disease are inspected. For the screening of motor speech programming abilities, signs of articulatory groping, or whole/part word transpositions of a sequence are monitored (St. Louis, 1981).

An oral mechanism examination is common for the screening of any abnormalities that may hinder an individual’s speech. A close look at each of the components of an oral mechanism examination allows a speech language pathologist to see which part of the speech mechanism may need to be further tested. The examination aids in isolating the target areas that need to be treated in therapy and helps to formulate treatment goals.

Somatosensory Perception

An oral mechanism examination focuses mainly on the physical appearances and capabilities of a client. However, somatosensation is an important factor to consider when dealing with speech dysarthrias. Traditionally speech language pathologists have focused on the motor aspects of speech disorders and used their subjective motor assessment to infer possible somatosensory deficits. Direct testing of somatosensory perception has been largely overlooked. When treating motor disorders, a speech language pathologist works with a patient to manipulate the patient’s sensory environment; e.g. help with placement and movement of lips, tongue, and face. Understanding the sensorimotor characteristics of speech dysarthrias may help speech language pathologists better assist patients and provide them with a more effective intervention plan. The DIVA model is one model that may help speech language pathologists better understand the interplay between somatosensation and production.

DIVA Model

The DIVA (Directions Into Velocities of Articulators) model of speech is a computational framework that lays out the neural network of the interactions involved in speech production. This model controls a computer stimulated vocal tract in order to produce speech sounds. Several regions of the brain are involved in speech acquisition and speech production, including the somatosensory cortex. The DIVA model highlights that when children are beginning to babble, they use their auditory cortex and somatosensory cortex to receive feedback. During babbling, children realize if they move their mouth a certain way a specific sound is elicited. They receive feedback from their somatosensory target and state maps that tells them they moved their mouth the correct way. The feedback also relays information if there was an error, i.e. an incorrect sound was produced, through the somatosensory error map. The DIVA model confirms the importance of sensation as part of the complex neural network involved in producing speech (Tourville, J.A. & Guenther, F.H., 2011). While the DIVA model suggests that high quality somatosensory capabilities are important for learning skilled orofacial activities, researchers are still investigating means of assessing orofacial somatosensation.

Devices Available

Although somatosensation is an important aspect to speech production, the only devices currently available for use in testing the orofacial region are devices that provide a high level of precision but are only available in laboratory settings and devices that are clinically available but have not been established as reliable in the orofacial region. Although laboratory testing offers a high degree of precision, it is both expensive and time consuming, making it difficult to use in clinical settings.

Two clinically available tools are two-point discrimination discs and Von Frey hairs. Two-point discrimination discs are in the shape of an octagon with receptors (i.e. points) ranging from one to eight (millimeters apart). Receptors are increasingly further apart as the numbers increase, with side one having only one receptor and side eight's two receptors being the furthest apart (or 8 mm). Von Frey hairs, also known as Semmes-Weinstein monofilaments, are a set of elastic columns that contain nylon filaments, or hairs, of ranging thickness that buckle at a specific force when applied to a surface.

Two-point discrimination has been used in a number of studies. Two-point discrimination was used in a study to test the effects of muscle fatigue on skin sensation in the upper and lower extremities (Han et al., 2015). In this study, two-point discrimination was conducted prior to muscle fatigue and after. After muscle fatigue was induced, there was an increase in two-point discrimination distance. Results concluded that muscle fatigue does have an effect on skin sensation Another study assessed the reliability of two-point discrimination tests in the neck, hand, back, and foot. After completion of the study, it was discussed that two-point discrimination, if conducted by a single clinician, was reliable (Catley et al., 2013). In a comparison of young and active elderly adults, three tests were completed including a two-point discrimination test in the sole of the foot. Results showed that the elderly group performed lower compared to the younger group; this conclusion was consistent with findings that elderly adults have sensory degeneration as they age (Franco, P.G., Santos, K.B., & Rodacki, A.L.F., 2015).

Semmes Weinstein monofilaments have been noted as low cost, non-invasive, and relatively easy to use. They have been widely used in the United States to evaluate neuropathy in those at risk for diabetes (Lavery et al., 2012). In cases of silent neuropathy, monofilaments have been particularly useful in the detection of sensory impairment. Monofilaments are applied to a body location, in this case a hand or foot, resulting in an indentation of the skin. This method measures the perception of touch. If somatosensation is diminished, the thickness of the monofilaments would increase until pressure from the indentation is felt by the participant (Santhanam, 2003).

Monofilaments are recognized and recommended by the World Health Organization as devices that can be used for repeatable testing and for measuring somatosensation in cutaneous regions, predominately in cases of leprosy and diabetes. Researchers have been successful in achieving somatosensation threshold estimates using these monofilaments, even in areas where there is thicker skin, such as the plantar hallux (Haloua, Sierevelt, & Theuvenet, 2011).

Purpose of Study

The primary aim of this study is to assess if two-point discrimination and Von Frey hairs can be reliably used in the orofacial region in healthy young adults. Currently, little research has been conducted with orofacial somatosensory testing in clinical settings. The purpose of this study is to assess the reliability of these two assessment tools in the labial and lingual regions of healthy young adults.

Chapter 3

Methods

Participants

Four participants, two males and two females, were recruited from The Pennsylvania State University. Each participant was twenty-one years old and self-reported as healthy. All participants were volunteers and unfamiliar to the testing protocol. They were screened to ensure they were alert, able to give consent, and met all study inclusion criteria. Criteria included participants being between 18 and 45 years old, in “good” general health, free of any craniofacial anomalies, and free of any speech disorders. The university’s ethics counsel approved this study prior to recruitment.

Screening information was gathered through self-report and completed prior to the assessment procedures. All participants reported they were free of any craniofacial anomalies, injuries, or active lesions to the lower face. They indicated their smoking history and background in music (i.e. playing an instrument that required use of their mouth for an extended period of time). On the day of testing, participants indicated their general health based on a five-point scale (poor, fair, good, very good, excellent). All participants denied being on, to the best of their knowledge, any medications that could cause excessive drowsiness, having had a recent dental visit that involved oral surgery or the use of any form of anesthesia, and having a speech disorder.

Pure tone hearing threshold assessments were completed at 500, 1000, 2000, and 4000 Hz. Participants were asked to identify their current level of speech use on a five-point scale with larger numbers indicating increased average speech use (Baylor, Yorkston, Eadie, Miller, & Amtmann, 2008). Participant group data for age, speech usage, smoking history, pure tone hearing threshold average, and history in playing brass or woodwind instruments are reported in Table 1.

Participant	**Age**	**Sex**	**Speech Usage**	**Smoking History**	**R-PTA**	**L-PTA**	**Musical History**
1	21	F	3	Yes	10.00	7.50	No
2	21	F	3	No	8.75	6.25	No
3	21	M	4	Yes	7.50	8.75	No
4	21	M	3	No	15.00	12.50	No

Table 1. Participant Data

Testing Procedures

Participants were seated in a comfortable and relaxed position during the assessment. All participants completed three assessments in the same order: two-point discrimination, detection thresholds, and discrimination thresholds. All assessments were completed on the left and right lips and tongue with the order of the four body locations randomized.

Two-Point Discrimination Threshold Estimates

Two-point discrimination thresholds estimates were achieved using Baseline 2-point Discrim-a-Gon discs and a Method of Limits (MoL) approach (Gesceider, 1997). The disc was placed at a perpendicular angle to the skin surface at either the lips or tongue, and depressed until the skin indented and then was removed. Using a Method of Limits approach the device was started at a supramaximal level, meaning the two points were exaggeratedly far apart to the point where the participant could clearly feel two distinct pressure points. The participant was instructed to identify the point at which they could no longer feel two points, but rather just one point of pressure. Distance between the points slowly decreased in one-millimeter increments until the participant indicated they felt only one point of pressure. Testing then began again with only one point of pressure with distance increasing until the participant identified feeling two points of pressure. A participant's threshold estimate was determined as the average of 6 trials, 3 ascending and 3 descending.

Tactile Detection Threshold Estimates

Bilateral lingual and labial tactile detection threshold estimates were completed using Aesthesio® Von Frey hair monofilaments. Threshold estimates were determined with the use of a two-alternative forced choice paradigm (Gescheider et al. 1994). Participants were instructed to choose one of the two sequentially presented intervals in which they felt the stimulus. The stimulus was randomly presented in only one of the two trials, indicated by the researcher saying "trial 1" and "trial 2". Participants were instructed to hold up one or two fingers to indicate the trial in which they felt the stimulus. All participants started at the 0.4 g level. If the participants gave three positive consecutive detections, the Von Frey filament was decreased to the next level of grams. Grams were increased to the next level if one detection, or missed response, occurred. Threshold detection estimate values were determined by either a participant giving five positive consecutive detections at the lowest level (0.008 g) or at five crossings of a given Von Frey filament value.

Tactile Discrimination Threshold Estimates

Discrimination thresholds estimates were additionally assessed using the Von Frey Hairs. They were completed bilaterally on the lips and tongue. Methods were similar to those used for tactile detection thresholds; however, for discrimination, participants were told they would feel pressure in both trials. Again, participants were asked to use their fingers to indicate which trial had the “stronger” pressure. Participants started their trials at three levels above their detection threshold level. Likewise, with tactile detection thresholds, if the participants gave three positive consecutive detections, the Von Frey filament went down a threshold to the next level of grams. One missed response resulted in an increase in grams or pressure.

Reliability Testing

All four participants were asked to return to repeat the testing protocol. The days between initial testing and reliability testing ranged from 11-17 days, in order to decrease the chance of a learning effect. Three of the four participants reported no change in their health status from their initial testing. One participant indicated an increase in health status, with no longer reporting a stomachache. Participants completed two-point discrimination thresholds, Von Frey hair detection and discrimination thresholds exactly as before in the initial testing, but with all four locations again randomized.

Participant	**Days between Testing**
1	17
2	12
3	12
4	11

Table 2. Difference in Days between Testing

Chapter 4

Results

To determine the reliability of the two-point discrimination, tactile detection, and tactile discrimination thresholds, the participants' data from initial testing was compared to their subsequent testing. Data was arranged into the three testing categories, with graphs displaying each of the participant's results.

Two-Point Discrimination Thresholds

Two point discrimination thresholds appeared stable across the two testing sessions (Figure 1). Two point discrimination discs follow a linear scale of one-millimeter increments. Each increment indicates a change within one-step. There were minimal changes between the initial testing and the reliability testing. Data for participant 1 shows that the detection levels for initial testing were higher for the right lip and left lip, with changes within two steps. The levels for the right tongue were a difference of 0.01 mm, or within one-step, across the two tests. The detection level for reliability testing was within a two-step change for the left tongue. Data for participant 2 shows detection levels for reliability testing to be higher for the right lip and the left lip with a one-step change. There was a slight difference of 0.005 mm, or less than a one-step change, for the right tongue. The left tongue detection levels displayed no difference across testing. Initial testing for participant 3 shows detection levels to be higher for the right lip and the right tongue, with the change within one-step. For the left lip and left tongue, detection levels for reliability testing proved to be higher but were within a one-step change. Although participant 4's detection levels for initial testing were higher across all test locations, these differences were within a one-step change. The differences between initial and reliability testing proved to be greater than the other three participants, with differences of 0.50 mm, 0.83 mm, 0.84 mm, and 0.50 mm. These differences are within a one-step change on the discrimination discs.

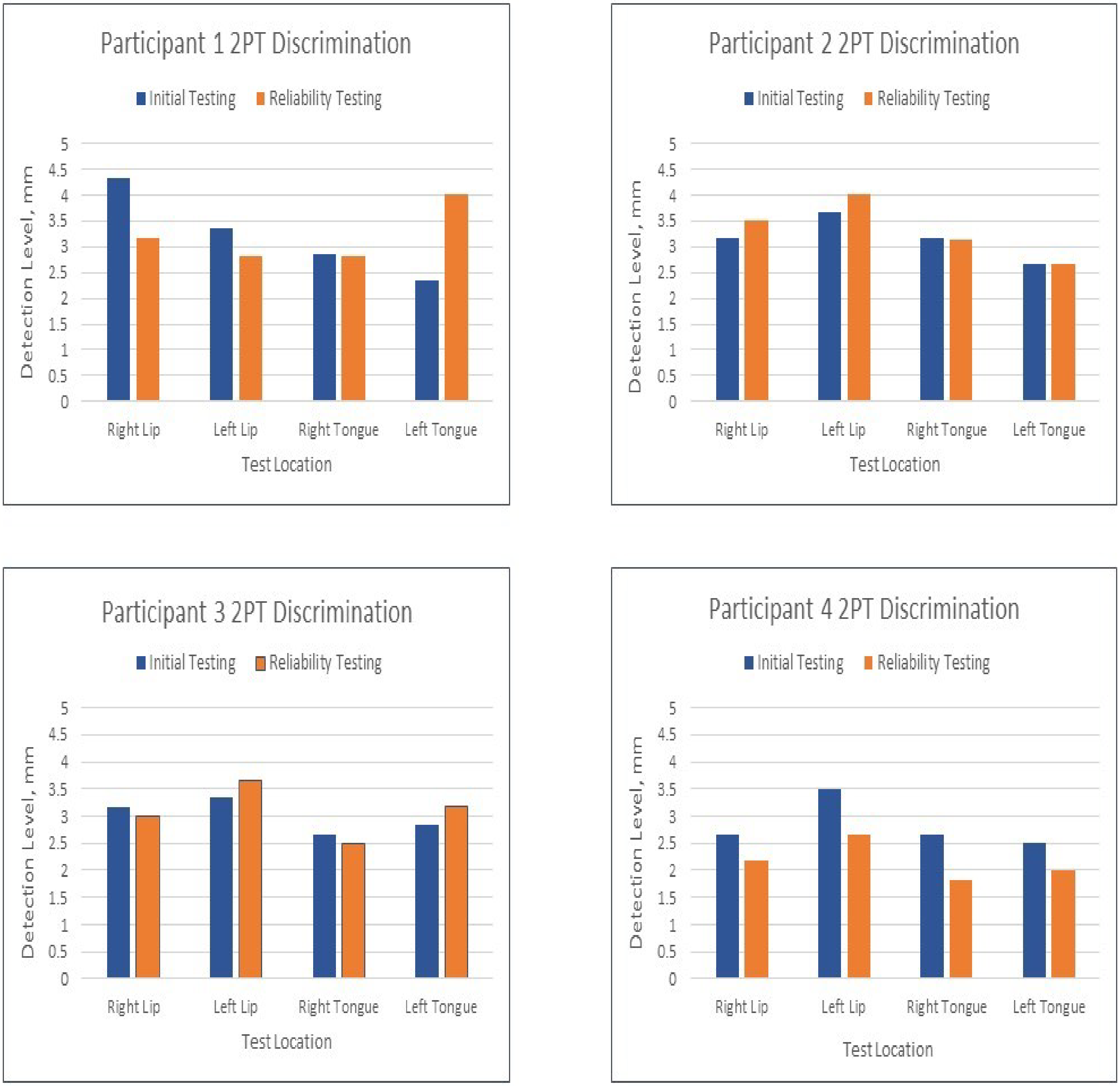

Figure 1. Two-Point Discrimination Thresholds

RIGHT LIP (2 Point Discrimination)			
Participant	**Initial Testing**	**Reliability Testing**	**Δ/ Difference**
1	4.34	3.17	-1.17 mm
2	3.17	3.50	-0.33 mm
3	3.17	3.00	0.17 mm
4	2.67	2.17	0.50 mm
LEFT LIP (2 PT Discrimination)			
Participant	**Initial Testing**	**Reliability Testing**	**Δ/ Difference**
1	3.34	2.83	0.51 mm
2	3.67	4.00	-0.33 mm
3	3.34	3.67	-0.33 mm
4	3.50	2.67	0.83 mm
RIGHT TONGUE (2 PT Discrimination)			
Participant	**Initial Testing**	**Reliability Testing**	**Δ/ Difference**
1	2.84	2.83	0.01 mm
2	3.17	3.12	0.005 mm
3	2.67	2.50	0.17 mm
4	2.67	1.83	0.84 mm
LEFT TONGUE (2 PT Discrimination)			
Participant	**Initial Testing**	**Reliability Testing**	**Δ/ Difference**
1	2.34	4.00	-1.66 mm
2	2.67	2.67	0.00 mm
3	2.84	3.17	-0.33 mm
4	2.50	2.00	0.50 mm

Table 3. Two Point Discrimination Data

Detection Threshold Estimates

Detection threshold estimates showed minimal change across participants (Figure 2). Von Frey hairs do not follow a linear scale. Increments are indicated as being a one Von Frey hair difference. For example if initial testing was 0.008 g and reliability testing was 0.02 g, that is a one Von Frey hair monofilament or one-step difference.

Participant 1 shows a 0.012 g difference for the right lip, or a one-step change. Data for the left lip, right tongue, and left tongue demonstrate no difference between the initial testing and the reliability testing. Participant 2 shows no difference across all test locations, with all detection levels at 0.008 g. Participant 3's detection levels for initial testing were higher for all test locations compared to their reliability testing, with differences of 0.02 g, 0.05 g, 0.012 g, and 0.032 g. Right lip and right tongue were within a one-step difference and left lip and left tongue were two-step changes. Participant 4 was consistent across test locations with detection levels at 0.008 g for both initial and reliability testing. All participants were within two steps for pre/post testing.

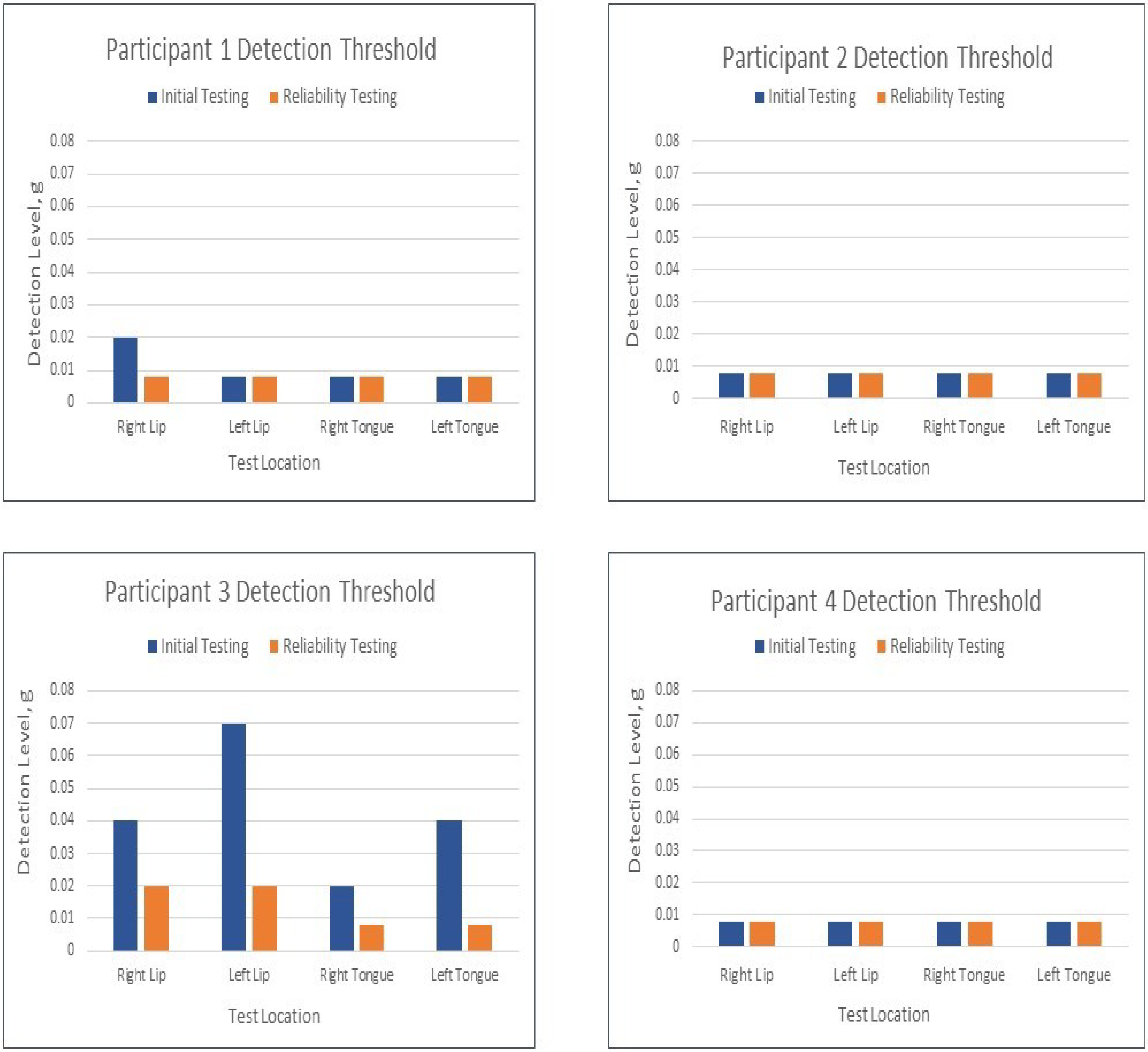

Figure 2. Tactile Detection Threshold Estimates

RIGHT LIP (Detection Threshold Estimates)			
Participant	**Initial Testing**	**Reliability Testing**	**Δ/ Difference**
1	0.02	0.008	0.012 g
2	0.008	0.008	0.00 g
3	0.04	0.02	0.02 g
4	0.008	0.008	0.00 g
LEFT LIP (Detection Threshold Estimates)			
Participant	**Initial Testing**	**Reliability Testing**	**Δ/ Difference**
1	0.008	0.008	0.00 g
2	0.008	0.008	0.00 g
3	0.07	0.02	0.05 g
4	0.008	0.008	0.00 g
RIGHT TONGUE (Detection Threshold Estimates)			
Participant	**Initial Testing**	**Reliability Testing**	**Δ/ Difference**
1	0.008	0.008	0.00 g
2	0.008	0.008	0.00 g
3	0.02	0.008	0.012 g
4	0.008	0.008	0.00 g
LEFT TONGUE (Detection Threshold Estimates)			
Participant	**Initial Testing**	**Reliability Testing**	**Δ/ Difference**
1	0.008	0.008	0.00 g
2	0.008	0.008	0.00 g
3	0.04	0.008	0.032 g
4	0.008	0.008	0.00 g

Table 4. Tactile Detection Data

Discrimination Threshold Estimates

Discrimination thresholds estimates and the difference between initial and reliability testing showed more variation within the participants (Figure 3). Similar to detection thresholds, increments are indicated as being a one Von Frey hair difference. Participant 1 shows no difference in discrimination level for the right lip. Initial testing for the left lip was slightly higher, with a one-step difference of 0.012 g. Discrimination thresholds for reliability testing for the right tongue and left tongue were higher, with a three step difference of -0.062 g and a one-step difference of -0.03 g. Participant 2 shows no difference in discrimination levels for the right lip, left lip, and left tongue. Initial testing discrimination level was higher than the discrimination estimate for reliability testing in the right tongue with a three-step difference of 0.062 g. For participant 3, there was a four-step difference of -0.152 g for the right lip, with the reliability testing having a higher. The left lip and left tongue show no difference. The discrimination threshold estimate for initial testing of the right tongue was higher, with a one-step difference of 0.09 g. The right lip and right tongue for participant 4 had higher discrimination threshold estimate for reliability testing with a two-step difference of -0.032 g and a three-step difference of -0.062 g. The left lip and left tongue's initial testing was higher than reliability testing with a three-step change of 0.062 g and a two-step change of 0.05 g. All participants were within a three-step change for pre/post testing, with the exception of a four-step difference of -0.152 g for participant 1's right lip.

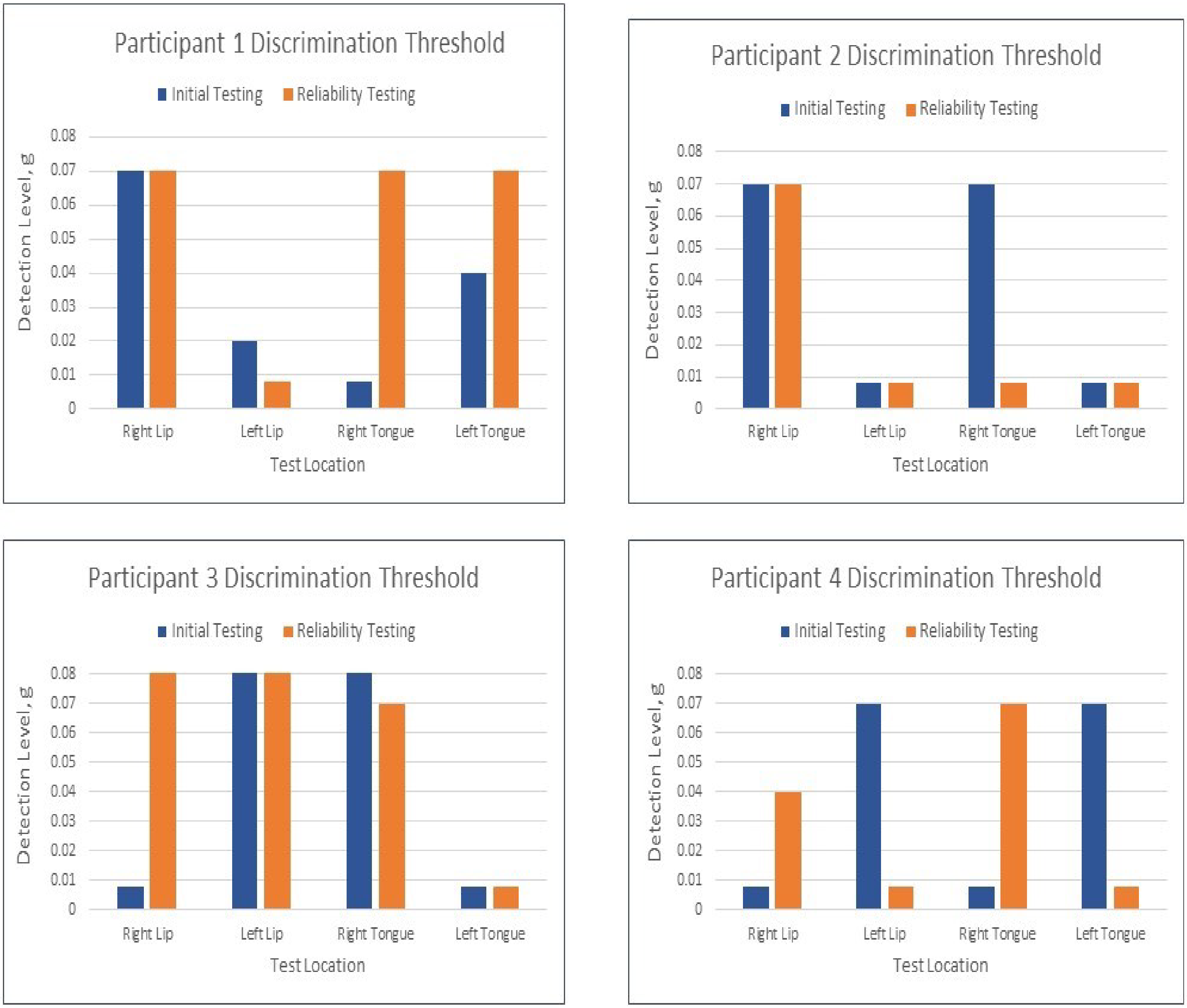

Figure 3. Tactile Discrimination Threshold Estimates

RIGHT LIP (Discrimination Threshold Estimates)			
Participant	**Initial Testing**	**Reliability Testing**	**Δ/ Difference**
1	0.07	0.07	0.00 g
2	0.07	0.07	0.00 g
3	0.008	0.16	-0.152 g
4	0.008	0.04	-0.032 g
LEFT LIP (Discrimination Threshold Estimates)			
Participant	**Initial Testing**	**Reliability Testing**	**Δ/ Difference**
1	0.02	0.008	0.012 g
2	0.008	0.008	0.00 g
3	0.016	0.16	0.00 g
4	0.07	0.008	0.062 g
RIGHT TONGUE (Discrimination Threshold Estimates)			
Participant	**Initial Testing**	**Reliability Testing**	**Δ/ Difference**
1	0.008	0.07	-0.062 g
2	0.07	0.008	0.062 g
3	0.16	0.07	0.09 g
4	0.008	0.07	-0.062 g
LEFT TONGUE (Discrimination Threshold Estimates)			
Participant	**Initial Testing**	**Reliability Testing**	**Δ/ Difference**
1	0.04	0.07	-0.03 g
2	0.008	0.008	0.00 g
3	0.008	0.008	0.00 g
4	0.07	0.02	0.05 g

Table 5. Tactile Discrimination Data

Chapter 5

Discussion/ Conclusion

Reliability of Von Frey hair monofilaments

While researching Von Frey hairs, the question pertaining to whether these clinically available tools were reliable was raised. Several articles pointed out variables that could hinder the reliability of these monofilaments. In a study conducted by Lavery et al., (2012), five brands of Semmes-Weinstein monofilaments from commercial vendors were obtained. Initial accuracy of the monofilaments and the degradation of the buckling force were found to vary. This study concluded that with different manufacturers, there is variability within and between devices. Lavery et al., (2012) also noted that though there is no data to guide a clinician in whether they should replace their monofilaments, it is suggested that they be replaced frequently. Manufacturers and the service life of monofilaments are aspects that should be considered when testing reliability.

Temperature and humidity can also have an effect on monofilaments. In a study by Haloua and colleagues, four filaments from sixteen monofilament cases were tested under varying (?) temperature and humidity conditions. Results indicated that temperature and humidity do have an effect on the buckling force of monofilaments. In the case of 80% humidity and a temperature of 37°C, the bending force of a filament decreased 33% to 48% (Haloua, Sierevelt, & Theuvenet, 2011). In a similar study, monofilaments were observed in a climate-controlled chamber. The monofilaments were exposed to six incremental changes in humidity, ranging from 20% to 79%. The conclusion drawn from this study is that even a fluctuation in relative humidity of 15% to 25% can have an effect on accuracy (Werner, Rotbøll-Nielsen, and

Ellehuus-Hilmersson, 2011). Incorrect application on the part of the clinician may also hinder reliability (Werner, Rotbøll-Nielsen, and Ellehuus-Hilmersson, 2011). Both the two-point discrimination disc and Von Frey hairs are applied in a specific manner. Each clinician involved in testing is responsible for following the guidelines for collecting data.

Each of these variables was considered prior to testing. Monofilaments were purchased from one manufacturer and the same monofilaments were used for both initial and reliability testing. Monofilaments were kept in the laboratory to limit temperature or humidity fluctuations. Clinicians that handled the two-point discrimination discs and Von Frey hairs were trained under the supervising clinician to ensure that testing was conducted in the same manner each time. The same study personnel tested all participants included in this study to limit variability.

Participant Perception

After reliability testing was completed, there were comments from participants pertaining to the tests. Some felt like they did better the second time around, and others felt like they did worse. There was the question of whether the tests evoked a learning effect or a feeling of helplessness. Some participants felt they had “learned” how to take these tests, such as knowing what to feel or what to pay attention to during testing. As a result, they felt more confident after the reliability testing ended. Others, particularly during two-point discrimination and discrimination threshold testing, resorted to guessing during testing. Testing lasted roughly an hour and was mentally challenging. Hints of frustration and exhaustion were seen during testing. The mental states of the participants appear not to have had an effect on results however. There were no discernable trend with how participants fared in testing compared to their perception of how testing had gone.

Although participants were given a description of the tests, the mental endurance that is required of this testing should be explained. In addition, it would be beneficial to the participants to explicitly explain that there is no “good” or “bad” individual results. The objective of the data collection is to compare the two rounds of testing for reliability.

Descriptive Analysis

Differences in data collected in initial and reliability testing were small. Since this study is part of a larger ongoing study, differences cannot be characterized as statistically significant. For two-point discrimination threshold estimates, differences ranged from -1.66 mm to 1.17 mm with an average difference of 0.085 mm. Detection threshold estimates ranged from 0.00 g to 0.05 g with an average difference of 0.008 g. Discrimination threshold estimates ranged from -0.152 g to 0.09 g with an average difference of 0.01 g. Although more work needs to be done to determine clinical significance, currently collected data indicate these clinically available assessment tools appear to be reliable.

Additional Research of Sensory Functioning

Two-point discrimination, specifically using the MacKinnon-Dellon Disk-Criminator® and the Aesthesiometer® Semmes-Weinstein monofilaments were used in a study to further learn about normal somatosensation values for facial areas. Four areas were tested bilaterally: cheek, non-glabrous skin of upper and lower lip, and mental region. Thresholds were determined using a “staircase limits method”. Semmes-Weinstein monofilaments’ values were similar when compared to previous studies that were done in the check, upper lip, and mental region. This study concluded that the use of these devices were useful in a clinical setting (Vriens, J. P. M., & van der Glas, H. W., 2009).

This study utilized a “staircase limits method” similar to the current study in order to generate an approximate threshold. The Disk-Criminator values for two-point discrimination were higher than values gathered in the current study; the means for the upper and lower lip were the closest in value with values at 6.0 mm and 5.6 mm for females and 6.6 mm and 6.1 mm for males (Vriens, J. P. M., & van der Glas, H. W., 2009). The values for the skin of the upper and lower lip were much higher compared to the values of the right and left lip in the current study. The variation in threshold estimates between the studies could be due to the different skin types (glabrous versus non-glabrous skin) tested. Values attained by the monofilaments were also higher, but values were again close when comparing lips in the current and discussed studies.

Although the study concluded that the Semmes-Weinstein monofilaments and the Disk-Criminator were appropriate for clinical practice, the study’s reliability is put into question. Normal values for facial sensation are derived from just one testing session and displayed as the values of healthy individuals. In addition, the reliability of the tools used is still uncertain. Hence, these values should be challenged and the participants re-tested for comparison. The current study attempted to counter the limitations described in this study by completing test-retest reliability. The data will go into a larger pool of participants to begin collecting normative data to assess the reliability of two-point discrimination and Von Frey hairs.

Conclusion

There were a number of factors that had the potential to diminish reliability, including manufacturer, service life, temperature/humidity, incorrect application, and the mentality of participants. Each factor was considered prior to testing. Although steps were taken, these variables could have had an effect on results. Although healthy young adults with no neurological history were recruited for this study, the mentality of participants should be examined further. It would not be beneficial to the participants or the clinician for the participants to feel as though they have to perform “well” on these sensation tests, or for them to resort to guessing during testing.

Data results are part of a descriptive analysis, and while no definite conclusion can be drawn from this study, it is hypothesized that two-point discrimination and Von Frey Hairs will be found reliable. The differences in initial and reliability testing performed by these two clinically available tools were relatively small. Due to the small difference noted in the current sample, it is recommended that reliability of two-point discrimination and Von Frey hairs continue to be tested in a larger study sample.

References

Baylor, C., Yorkston, K., Eadie, T., Miller, R., & Amtmann, D. (2008). Levels of Speech Usage: A Self-Report Scale for Describing How People Use Speech. Journal of Medical Speech-Language Pathology, 16(4), 191-198.

Catley, M. J., Tabor, A., Wand, B. M., & Moseley, G. L. (2013). Assessing tactile acuity in rheumatology and musculoskeletal medicine--how reliable are two-point discrimination tests at the neck, hand, back and foot? Rheumatology (Oxford, England), 52(8), 1454.

Duffy, J. R. (2005). Motor speech disorders: Substrates, differential diagnosis, and management (2nd ed.). St. Louis, Mo: Elsevier Mosby.

Franco, P. G., Santos, K. B., & André L. F. Rodacki. (2015). Joint positioning sense, perceived force level and two-point discrimination tests of young and active elderly adults. Revista Brasileira De Fisioterapia, 19(4), 304-310. doi:10.1590/bjpt-rbf.2014.0099

Gescheider, G.A., Bolanowski, S.J., Zwislocki, J.J., Hall, K.L., & Mascia, C. (1994). The effects of masking on the growth of vibrotactile sensation magnitude and on the amplitude difference limen: A test of the equal sensation magnitude-equal difference limen hypothesis. The Journal of the Acoustical Society of America, 96(3), 1479-1488. doi:10.1121/1.410290

Gescheider, G. A. (1997). Psychophysics: the fundamentals (3rd ed.). Mahwah, N.J.: L. Erlbaum Associates.

Haloua, M. H., Sierevelt, I., & Theuvenet, W. J. (2011). Semmes-weinstein monofilaments: Influence of temperature, humidity, and age. Journal of Hand Surgery, 36(7), 1191-1196. doi:10.1016/j.jhsa.2011.04.009

Han, J., Park, S., Jung, S., Choi, Y., & Song, H. (2015). Comparisons of changes in the two-point discrimination test following muscle fatigue in healthy adults. Journal of Physical Therapy Science, 27(3), 551-554. doi:10.1589/jpts.27.551

Lavery, L., Lavery, D., Lavery, D., LaFontaine, J., Bharara, M., & Najafi, B. (2012). Accuracy and durability of semmes-weinstein monofilaments: What is the useful service life? Diabetes Research and Clinical Practice, 97(3), 399-404. doi:10.1016/j.diabres.2012.04.006

Santhanam, A. (2003). Silent neuropathy: Detection and monitoring using Semmes-Weinstein monofilaments. Indian Journal Of Dermatology, Venereology & Leprology, 69(5), 350-352.

St. Louis, K. O. (1981). Oral speech mechanism screening examination (OSMSE). Baltimore, Md.: University Park Press.

Tourville, J. A., & Guenther, F. H. (2011). The DIVA model: A neural theory of speech acquisition and production. Language and Cognitive Processes, 26(7), 952–981. http://doi.org/10.1080/01690960903498424

Vriens, J. P. M., & van der Glas, H. W. (2009). Extension of normal values on sensory function for facial areas using clinical tests on touch and two-point discrimination. International Journal of Oral & Maxillofacial Surgery, 38(11), 1154-1158. doi:10.1016/j.ijom.2009.06.006

Werner, M. U., Rotbøll-Nielsen, P., Ellehuus-Hilmersson, C., Medicin (Lund), Faculty of Medicine, Medicine (Lund). . Sektion I-II. (2011). Humidity affects the performance of von frey monofilaments. Acta Anaesthesiologica Scandinavica, 55(5), 577-582. doi:10.1111/j.1399-6576.2011.02426

ACADEMIC VITA

Olivia Miller
oqm5041@psu.edu

EDUCATION

The Pennsylvania State University
University Park, PA
The Schreyer Honors College | The College of Health and Human Development
Bachelor of Science in Communication Sciences and Disorders
Minor in Human Development and Family Studies

RESEARCH

The Pennsylvania State University
University Park, PA
Thesis in partial fulfillment of the Honors College Requirements
- Title: Testing the Reliability of Clinically Available Tools for Orofacial Somatosensory Testing
- Supervisor: Dr. Nicole Etter

LEADERSHIP & INVOLVEMENT

Audiology Club *Sept. 2012-Present*
University Park, PA
- Facilitate meetings, organize speakers, and plan activities in order to educate students about this professional branch within the Communication Sciences and Disorders major
- Served as President, Secretary, and Alumni Chair

The Women's Leadership Initiative *Aug 2014-May 2015*
University Park, PA
- Selected as one of thirty-two women within the Colleges of Health and Human Development & Nursing based on leadership potential, academic achievement, and commitment to service
- Developed the core values, attitudes, and competencies to build a strong foundation to be a life-long leader through service, education, reflection, and a mentoring program

The Centre County Down Syndrome Society *Jan 2015-Apr 2015*
State College, PA
- Volunteer with the For Good Performance Troupe
- Helped to run weekly rehearsals for a musical performance for young adults with Down syndrome

Penn State's College of Health and Human Development JumpStart Retreat *Summers 2013-2015*
University Park, PA
- Collaborated with team members to provide incoming freshmen information about the transition to college and to introduce them to the College of Health and Human Development

WORK EXPERIENCE

The Child Care Center at Hort Woods
University Park, PA

Teacher Assistant *Sept 2012-Present*

- Aid teachers in the care and supervision of preschoolers during nap time, lunchtime, outdoor activities, and classroom activities
- Employed 10-12 hours weekly while full-time student

Support Staff *Summers 2014-2015*

- Operated as an active teacher in infant/toddler and preschool classrooms
- Led classroom schedule and activities

Summer Camp Teacher *Summer 2015*

- Responsible for the care of school age children grades one through five
- Organized and supervised educational and fun daily activities

AWARDS & INTERESTS

- Recipient of the Nancy Colfelt Fund for demonstrating academic merit, financial need, and a work history, *Spring 2016*
- Recipient of the Communication Disorders Scholarship Award for demonstrating outstanding professional potential and exemplary achievement, *Summer 2015*
- Schreyer Honors College Gateway Scholars Program Scholarship, *Summers 2014-2015*
- Dean's List, *Fall 2012-Fall 2015*
- The College of Health and Human Development Honors Society, *Fall 2013-Present*
- National Student Speech-Language Hearing Association Member, *Fall 2012-Present*
- Member of Phi Eta Sigma National Honors Society, *Spring 2013-Spring 2014*