**Statistical Design Consulting**

**SEMESTER REPORT**

**Fall 2024**

**Client:** Macy Griffis  **File Number:** 24-023

**Department:** Speech Language Pathology **Major Prof:** Dr. Georgia Malandraki

**Consultant:** Sumeeth Guda **Follow Up Date:** 09/18/24

**Meeting Attendees:** Macy Griffis, Sumeeth Guda, Dr. Georgia Malandraki, Dr. Bruce Craig

**Statement of Problem:** To identify neuromuscular amplitude and timing characteristics of typical swallows and compare to rehabilitative swallowing maneuvers in idiopathic Parkinson's disease patients.

**Goal of This Project:** Master’s Thesis

**Background:**

The client’s research is about studying swallowing techniques among people with Parkinson’s disease. The two most common rehabilitation techniques for swallowing and dysphagia are the Mendelsohn maneuver and effortful swallow. One of the major issues in patients affected with diseases that affect the head, and neck is that they have difficulty swallowing. What the client is trying to determine is which exercises and maneuvers are most effective to rehabbing the swallowing among patients with Parkinson’s disease.

The client has collected data from a group of patients with idiopathic Parkinson’s disease and dysphagia (n=15). The patients wore a sEMG (surface electromyography) sensor system developed by the I-EaT lab (i-Phagia system) to collect submental (i.e., below the chin) muscle activity. Participants performed two trials each of the following four tasks:

1. Typical swallow, 5ml thin liquid
2. Typical swallow - 5cc pudding
3. Swallows using a swallow maneuver (Mendelson maneuver)
4. Swallows using maximum effort (effortful swallow)

The experimental factors include the patient population (idiopathic Parkinson’s), as well as the labeling of the swallowing tasks (effortful swallow, Mendelsohn maneuver, and typical swallow 1 and 2) Surface EMG will be used to quantify muscle activity in the study. The client will consider three outcome variables of each trial in the study that summarize the sEMG signals: normalized mean sEMG amplitude, time to peak, and burst duration.

* The normalized mean sEMG amplitude is measured in % of maximum effort and indicates the level of muscle contraction and force.
* Time to peak is the duration from the onset of contraction to the time of peak amplitude (measured in seconds). This indicates how quickly a muscle reaches its maximal activation from the onset of muscle activity. The burst duration is the total duration of the muscle contraction during an event (measured in seconds) detected on the EMG device.

Previously the client and consultant worked together to validate the randomized complete block design assumptions and to show the right and left sides for the sensors performed approximately the same. A follow-up meeting was determined because the client needed help answering the following research question:

* How to compare neuromuscular amplitude and timing components of rehabilitative swallowing maneuvers (effortful swallow, Mendelsohn maneuver) with typical swallows (5mL thin liquid and 5cc pudding) in patients with idiopathic PD.

**Progress During Current Semester:**

The main objective of this semester was to wrap up the analysis of Macy’s project because she would not be as available to work on this project in the spring semester and she would need to answer the aim 1 and aim 2 analysis questions. In the summer semester Sumeeth created a visual to answer her aim 1 question which was to validate wether side was important in the model. However, in the fall semester, Macy and Dr. Malandraki wanted a more formal way to validate that the sides were different for the swallows. Sumeeth worked with Dr. Craig to test the following type of model:

lmer(response ~ task\*side + (1|patient) + (1|patient:task) + (1|patient:side), data), and validate whether patient and side were necessary for the model responses (AD, AM, TTP, BD), or if the model response needed to be scaled. The covariance structure was determined using BIC, and residual plots.

After this was fitted, the covariance structure was determined. Macy’s aim 2 analysis had to be solved. The aim 2 being wether the control swallows (5ml water, pudding) were different from the rehab swallows (Effortful Swallow, Mendelsohn Maneuver). Additionally, Dr. Malandraki wanted to see if the average between the control swallows was different than the rehab swallows. Overall, 6 comparisons would be made, and the composite task comparison would be made using linear contrasts.

Sumeeth solved this by using a Tukey test with a Kenward-Roger’s adjustment and comparing the significant differences between the tasks. Originally the project deliverable would be in R, however Sumeeth did the project in both SAS and R since his R couldn’t support any linear contrast libraries such as emmeans.

In the end Sumeeth presented the results to Macy, including a document with the analysis of the data. As well as validating her understanding of the results.

This project is mostly complete; however, Macy will be periodically checking in during the spring semester for clarification of her understanding of the analysis, or requesting feedback from Sumeeth about the results.

**Current Status: Continuing**