**ANALYSIS FILES/STEPS:**

1. Data cleaning code (data-cleaning-code)
   1. PACKAGES:
      1. Tidyverse for ggplot, magriterr, etc
      2. Readxl for reading in data
      3. Writexl for write\_xlxs function
   2. Loaded individual datasets from each coder (measurement data only)
   3. Deleted one scan that was coded by two coders (Jared and Kayna, kept Kayna’s)
   4. Added “coder” column with name of each coder to each individual dataset
   5. Compiled all individual datasets into one dataset
   6. Renamed columns with abbreviations of measurements (Appendix A? of dissertation)
   7. Imported demographic dataset
   8. Recoded race/ethnicity with abbreviations in Table 3.3? of dissertation
   9. Added age group column
   10. Set and double checked variable classifications (numeric vs char vs factor)
   11. ***Created headscan\_full excel***
       1. ***All participants, all measurement values***
       2. ***Includes visual and statistic outliers, and NA values***
       3. ***All demographic categories are retained***
       4. ***Headscan measure data had 2021, demographic data had 2017***
          1. ***When joined, 2016 obs of 33 variables***
2. Demographic data exploration (demographic-data-exploration)
   1. PACKAGES:
      1. Tidyverse for ggplot, magriterr, etc
      2. Readxl for reading in data
      3. Extrafont to make plots in times new roman
      4. Flextable for flextable() with custom function (allows times new roman)
   2. Loaded headscan\_full
   3. Numeric age info:
      1. Table of sumstats
      2. Histogram of age frequency
   4. Race/ethnicity (all categories retained) info:
      1. Table of sumstats
      2. Boxplot of age by race/eth category
      3. Histogram of race/eth category frequencies
   5. Gender (all categories retained) info:
      1. Table of sumstats
      2. Boxplot of age by gender category
      3. Histogram of race/eth category frequencies
   6. Age group info:
      1. Table of sumstats
      2. Boxplot of age (num) by age group
      3. Histogram of age group frequencies
   7. Headscan sample demographics plot of age, sorted by race/eth, color by gender
   8. Couple of other plots (not that great)
3. Summary stats SA1 (summary-stats-SA1)
   1. PACKAGES:
      1. Tidyverse for ggplot, magriterr, etc
      2. Readxl for reading in data
      3. Extrafont to make plots in times new roman
      4. Flextable for flextable() with custom function (allows times new roman)
      5. Writexl for write\_xlxs function
      6. Forcats for fct\_reorder
   2. Loaded headscan\_full
   3. Transformed all measurement data from centimeters to millimeters
   4. ***Created measureNAs excel***
      1. ***Sum of NA values per measurement***
      2. ***Proportion of NA values per measurement***
   5. Measurement NA info:
      1. Table of proportion and sum of na values per each measurement location
      2. (CREATE NEW TABLE IN ORDER OF NA)- couldn’t figure out how to do this, flextable wants to do alphabetical
      3. Histogram of missing value ordered by measurement location (one for count, one for prop)
   6. Overall, race/eth, gender, age sumstats for all measurements!
      1. Histogram of measurement frequency
      2. Table of overall measurement sumstats
      3. Table of all race/eth categories sumstats
      4. Boxplots (ordered and not) of measurement by all race/eth categories
      5. Table of all gender categories sumstats
      6. Boxplots (ordered and not) of measurement by all gender categories
      7. Table of all age group categories sumstats
      8. Boxplots (ordered and not) of measurement by age group categories
   7. Removed visual outliers and redeveloped all of above for following measurements:
      1. GoSub\_C
      2. NRB\_L
      3. SelDH\_C
      4. SnasM\_C
      5. TrGo\_C
      6. TrSman\_C
      7. TrSnas\_C
4. Removing visual outliers (removing-visual-outliers)
   1. PACKAGES:
      1. Tidyverse for ggplot, magriterr, etc
      2. Readxl for reading in data
      3. Extrafont to make plots in times new roman
      4. Flextable for flextable() with custom function (allows times new roman)
      5. Writexl for write\_xlxs function
   2. Loaded headscan\_full
   3. Changed measurement data in cm to mm
   4. For all 7 above measures:
      1. Looking at histogram with all data
      2. Checking max value
      3. Change values close to max (visual outliers) to NA
      4. Checking how many values were filtered out
      5. Histogram of filtered data
   5. ***Created headscan\_full1 excel***
      1. ***2016 obs of 33 vars***
      2. ***26 individual measurement values changed to NA based on visual outlier status***
      3. ***Numeric measurement data changed from cm to mm***
   6. ***Created all\_vis\_out1 excel***
      1. ***2 columns:***
         1. ***ID: id number***
         2. ***Vis\_out: what was the measurement that was changed to NA in headscan\_full1 dataset***
5. Bivariate panel
   1. PACKAGES:
      1. Tidyverse for ggplot, magriterr, etc
      2. Readxl for reading in data
      3. Extrafont to make plots in times new roman
      4. rstatix for identify\_outliers
   2. Loaded headscan\_full1
   3. Made panel numbers dataframe to be able to use geom\_text inside geom\_rect(angle)
      1. From Zhuang 2007 article
   4. Generated bivariate panel with face width (Sellion menton length) and face width (bizygomatic length)
      1. Original zhaung 2007 panel overlaid
   5. Investigated and changed one outlier for face length to NA (using rstatix identify\_outliers)
   6. Generated same bivariate plot as above (d)
   7. Generated bivariate plot colored by gender
   8. Generated bivariate plot colored by age group
   9. Generated bivariate plot colored by race/eth
6. Exploring measurement variables
   1. PACKAGES:
      1. Tidyverse for ggplot, magriterr, etc
      2. Readxl for reading in data
      3. Extrafont to make plots in times new roman
      4. Flextable for flextable() with custom function (allows times new roman)
      5. Writexl for write\_xlxs function
      6. Corrr for correlate() function
      7. Ggcorrplot for correlation plot in times new roman
      8. Ggrepel for geom\_text\_repel
   2. Loaded headscan\_full1
   3. Created headscan\_num with only measurement variables (did not save excel)
   4. ***Used correlate from corrr package to create correlation\_data\_full dataset***
      1. ***Top and bottom correlation spreadsheet (duplicates)***
   5. ***Created correlation\_data and deleted code! Because it was edited in excel***
      1. ***Bottom only correlation spreadsheet (no duplicates)***
   6. Generated correlation plot using ggcorrplot (after some dataframe manipulation to wide dataframe)
   7. Loaded correlation\_data
   8. Pivoted longer and added column that lists “first & second” measure
   9. Removed missing values (same measure correlation)
   10. Generated table that lists first&second and correlation rounded to 4 digits
   11. Generated table as above sorted high to low correlation- couldn’t figure out how to do this, flextable wants to do alphabetical
   12. Created high\_cor dataframe with only correlation values over 0.7
       1. Considered highly correlated for this research
   13. Generated table of highly correlated measures
   14. Plot of correlations over 0.7
   15. From headscan\_full1 dataset, created dataset called coders (not to excel)
   16. Generated plot of how many participants each data collector digitized
   17. ***Loaded intraRR dataset (created in excel from Isabel thesis)***
   18. Generated plot of intraRR values wrapped by coder
   19. ***Created 4 excel spreadsheets for intraRR:***
       1. ***Kayna\_intra, Isabel\_intra, chandler\_intra, jared\_intra***
       2. ***Same as intraRR dataset but separated by coder***
   20. Generated plot of intraRR icc values ordered from low to high for all coders
   21. Created low\_intraRR dataframe by filtering to only icc values lower than 0.9
       1. Added column ‘percent coded’ indicating how much each data collector did
   22. Generated plot of low icc values wrapped by coder
   23. Generated dodge histogram of low icc values for all coders (color by coder)
   24. Created high\_cor\_full for values with high correlation
   25. Full joined low\_intraRR and high\_cor\_full by (first) measure
       1. Shows measurements of ‘concern’ or questionable measures
   26. Generated plot of correlation by intraRR icc values
   27. Generated plot of correlation by intraRR icc values wrapped by coder
   28. Generated plot of InterRR values ordered low to high icc
   29. Generated plot of just low interRR (after filtering to new dataframe)
   30. Generated plot of correlation by interRR icc values
   31. Generated plot of intraRR by interRR icc values wrapped by coder
   32. Generated plot of questionable stats by per measure (number)
   33. ***Created questionable measures excel, measures in this include:***
       1. ***All interRR iccs below 0.9***
       2. ***All intraRR iccs below 0.9***
       3. ***All correlation values 0.7***
       4. ***Indication for what measurements are involved***
7. Cors-interintra-nas
   1. PACKAGES:
      1. Tidyverse for ggplot, magriterr, etc
      2. Readxl for reading in data
      3. Extrafont to make plots in times new roman
      4. Flextable for flextable() with custom function (allows times new roman)
      5. Writexl for write\_xlxs function
   2. Loaded several datasets
   3. Generated table of all correlations, na proportion, all coder intraRR, interRR
      1. This was used by me to develop choosing-measurement-vars doc
   4. Generated tables for highly correlated variables, including all of above info
      1. AA\_C, ProA\_L, ProA\_C
      2. BiW\_C and BiW\_L
      3. SnasM\_L, SnasM\_C, SelM\_L
      4. TrSel\_C, TrSnas\_C, TrTr\_C, TrTr\_L (twice, oops)
      5. SelP\_L and SelP\_C
      6. ProS\_C and ProS\_L
      7. SmanM\_C and SmanM\_L
   5. All of this info was used in choosing measurement variables
8. Outlier remove and imputation
   1. PACKAGES
      1. Tidyverse for ggplot, magriterr, etc
      2. Readxl for reading in data
      3. Extrafont to make plots in times new roman
      4. Flextable for flextable() with custom function (allows times new roman)
      5. Writexl for write\_xlxs
      6. rstatix for identify\_outliers
      7. fauxnaif for na\_if\_in
      8. missMDA for imputePCA
   2. Loaded headscan\_full, with NAs and visual outliers
   3. Created chosen\_data dataframe with only 12 chosen measurement variables and factor variables
   4. Generated table of proportion and count of NA values
   5. Identified univariate outliers using identify\_outliers
      1. Univariate outliers identified overall, and for race/eth, gender,and age
      2. Generated tables that indicate outlier status of overall, and for each factor
      3. Generated bar charts of measurement distribution for all 12 measurements
   6. Identified multivariate outliers using mahalanobis and p values (<0.0001 = yes, outlier)
   7. Added column indicating offending univariate outliers
   8. Created combin\_out1 dataframe combining indication of uni and multi outliers
      1. Generated table of all outlier IDs indicating all of above
   9. Loaded all\_vis\_out1 (vis\_outliers)
      1. Filtered visual outliers to only 12 chosen measurements
   10. Joined visual and stat outlier dataframes
   11. Manipulated dataframe to have ID’s not repeat
   12. Generated table that indicates visual, multivariate, and univariate outlier status (and offending measures)
       1. 4 visual outliers
       2. 25 univariate outliers
       3. 18 multivariate outliers
       4. Above has overlap!
   13. Changed all measurement values to NA for multivariate outliers
   14. Changed specific measurement values to NA for univariate outliers
   15. **Created chosen\_withna excel**
       1. **2016 rows, all outliers changed to NA and retained in dataset**
   16. **Created chosen\_nona excel**
       1. **1677 rows, all rows with outliers/NA values removed**
          1. 17% of data lost
   17. Imputed NA data using imputePCA, estimncpPCA used to find ncp #
   18. **Created chosen\_imputed excel**
       1. **2016 full rows of data**
       2. **1122 missing measurement values imputed out of 24192 total values**
          1. **4.638% of values imputed**
9. Comparing imputed and non sumstats
   1. PACKAGES:
      1. Tidyverse for ggplot, magriterr, etc
      2. Readxl for reading in data
      3. Extrafont to make plots in times new roman
      4. Flextable for flextable() with custom function (allows times new roman)
      5. Pysch for describe function
   2. Loaded chosen\_withna and filtered to only numeric measurement values
   3. Calculated n, na, min, max, mdn, sd, se, and quantiles (5th, 25th, 50th, 75th, 95th) for each measurement WITHOUT imputation
      1. Generated table of above
   4. Loaded chosen\_imputed and filtered to only numeric measurement values
   5. Calculated n, na, min, max, mdn, sd, se, and quantiles (5th, 25th, 50th, 75th, 95th) for each measurement WITH imputation
      1. Generated table of above
   6. Generated table of differences between withna and imputed sumstats
10. Exploring demographics post-impute
    1. PACKAGES:
       1. Tidyverse for ggplot, magriterr, etc
       2. Readxl for reading in data
       3. Extrafont to make plots in times new roman
       4. Flextable for flextable() with custom function (allows times new roman)
       5. Forcats for fct\_reorder
    2. For chosen\_withna
       1. Generated histogram of race\_eth frequency
       2. Generated histogram of gender frequency
       3. Generated histogram of age group frequency
    3. For chosen\_nona
       1. Generated histogram of race\_eth frequency
       2. Generated histogram of gender frequency
       3. Generated histogram of age group frequency
    4. For chosen\_imputed
       1. Generated histogram of race\_eth frequency
       2. Generated histogram of gender frequency
       3. Generated histogram of age group frequency
11. PCA
    1. PACKAGES:
       1. Tidyverse for ggplot, magriterr, etc
       2. Readxl for reading in data
       3. Extrafont to make plots in times new roman
       4. Flextable for flextable() with custom function (allows times new roman)
       5. Writexl for write\_xlxs function
       6. GGfortify for autoplot function
       7. Scales for percent function
    2. Loaded headscan\_full1 with visual outliers as NA values
    3. Loaded measureNAs dataset
    4. Generated table of NA values in chosen vars
    5. Generated plots of NA values in chosen vars
    6. Dropped NA values from measurement vars, added demographic variables back in
       1. PCAdata\_full dataframe
    7. Removed ID column from PCAdata\_num and PCAdata\_full
    8. Following link in R code, ran PCA:
       1. PCA data was scaled using prcomp(data, scale=TRUE)
       2. PCA data were rotated by -1
       3. Variance explained was gathered using equation:
          1. SD^2/sum(SD^2)
    9. Scree plot generated using qplot
    10. Variance explained manipulated into dataframe
    11. Scree plot generated using ggplot
    12. Manipulated x variable of PCA output to match PCA2.Rmd
        1. Plots were same, but mirrored and rotated
        2. Went with PCA2 as better due to
           1. more prevalence of that process online
           2. the ability to use that process with ggplot (and make ellipses)
    13. Used autoplot to generate plots of pc1 and pc2
        1. No color coding
        2. Race/eth
        3. Race/eth Loadings displayed
        4. Gender
        5. Gender loadings displayed
        6. Age group
        7. Age group loadings displayed
12. PCA2
    1. PACKAGES:
       1. Tidyverse for ggplot, magriterr, etc
       2. Readxl for reading in data
       3. Extrafont to make plots in times new roman
       4. Flextable for flextable() with custom function (allows times new roman)
       5. Fauxnaif for na\_if\_in
       6. Reshape2 for melt
       7. FactoMineR for PCA
    2. Loaded chosen\_nona
    3. Centered and scaled data (function found online, link in code)
    4. Created PCA columns in dataframe
    5. Manipulated a couple of columns for data plotting
    6. Used ggplot to generate plots of pc1 and pc2
       1. No color coding
       2. Race/eth
       3. Race/eth with ellipses all categories
       4. Race/eth with ellipses four most common race/eth categories with other shown
       5. Race/eth with ellipses four most common race/eth categories with other not shown
       6. Black, Asian, other with ellipses
       7. Black and Asian with ellipses
       8. Gender
       9. Gender with ellipses all categories
       10. Gender with ellipses two most common gender categories with other shown
       11. Gender with ellipses two most common gender categories with other not shown
       12. Age
       13. Age with ellipses all categories
13. PCA-imputed
    1. Same as PCA file, but with imputed\_data
14. PCA2-imputed
    1. Same as PCA2 file, but with imputed\_data
15. MANOVA demographics post imputation
    1. PACKAGES:
       1. Tidyverse for ggplot, magriterr, etc
       2. Readxl for reading in data
       3. Extrafont to make plots in times new roman
       4. Flextable for flextable() with custom function (allows times new roman)
       5. Writexl for write\_xlxs function
       6. Forcats for fct\_reorder
    2. Loaded chosen\_withna, chosen\_nona, chosen\_imputed
    3. For chosen\_withna1, demographics abbreviated
       1. Generated histogram of race\_eth frequency
       2. Generated histogram of gender frequency
       3. Generated histogram of age group frequency
    4. For chosen\_nona1, demographics abbreviated
       1. Generated histogram of race\_eth frequency
       2. Generated histogram of gender frequency
       3. Generated histogram of age group frequency
    5. For chosen\_imputed1, demographics abbreviated
       1. Generated histogram of race\_eth frequency
       2. Generated histogram of gender frequency
    6. **Created chosen\_withna1 excel**
       1. **2016, all outliers changed to NA and retained in dataset**
       2. **AIAN, NHOPI, and PTNS changed to other**
       3. **Non-binary or other and prefer to not say changed to other**
    7. **Created chosen\_nona1 excel**
       1. **1677 rows, all rows with NA values (outliers removed and original missing values) removed**
          1. **17% of data lost**
       2. **AIAN, NHOPI, and PTNS changed to other**
       3. **Non-binary or other and prefer to not say changed to other**
    8. **Created chosen\_imputed1 excel**
       1. **2016 full rows of data**
       2. **1122 missing measurement values imputed out of 24192 total values**
          1. **4.638% of values imputed**
       3. **AIAN, NHOPI, and PTNS changed to other**
       4. **Non-binary or other and prefer to not say changed to other**
16. MANOVA data transformations test
    1. PACKAGES:
       1. Tidyverse for ggplot, magriterr, etc
       2. Readxl for reading in data
       3. Extrafont to make plots in times new roman
       4. Flextable for flextable() with custom function (allows times new roman)
       5. Corr for correlate function
       6. Corrplot for corrplot function
    2. Loaded chosen\_nona1
    3. Found correlations and generated corrplot
    4. Fit manova model (type I) using base R
       1. Order gender + race\_eth + age\_group
       2. Generated fitted vs. resids plot
          1. Homogeneity of covariances: striations are not concerning, they represent each individual value
       3. Generated QQ plot
          1. Normality
       4. Generated normality histogram
          1. Normality
    5. LOG BASE 10 transformation: Fit manova model (type I) using base R
       1. Order gender + race\_eth + age\_group
       2. Generated fitted vs. resids plot
          1. Homogeneity of covariances: striations are not concerning, they represent each individual value
       3. Generated QQ plot
          1. Normality
       4. Generated normality histogram
          1. Normality
    6. LOG BASE e transformation: Fit manova model (type I) using base R
       1. Order gender + race\_eth + age\_group
       2. Generated fitted vs. resids plot
          1. Homogeneity of covariances: striations are not concerning, they represent each individual value
       3. Generated QQ plot
          1. Normality
       4. Generated normality histogram
          1. Normality
    7. Square root transformation: Fit manova model (type I) using base R
       1. Order gender + race\_eth + age\_group
       2. Generated fitted vs. resids plot
          1. Homogeneity of covariances: striations are not concerning, they represent each individual value
       3. Generated QQ plot
          1. Normality
       4. Generated normality histogram
          1. Normality
17. MANOVA assumptions
    1. PACKAGES:
       1. Tidyverse for ggplot, magriterr, etc
       2. Readxl for reading in data
       3. Extrafont to make plots in times new roman
       4. Flextable for flextable() with custom function (allows times new roman)
       5. Corr for correlate function
       6. Corrplot for corrplot function
       7. Heplots for boxM function
       8. DFA.CANCOR for HOMOGENEITY (did not actually use)
    2. Loaded chosen\_nona1
    3. Found correlations and generated corrplot
    4. Fit manova model (type I) using base R
       1. Order gender + race\_eth + age\_group
       2. Generated fitted vs. resids plot
          1. Homogeneity of covariances: striations are not concerning, they represent each individual value
       3. Generated QQ plot
          1. Normality
       4. Generated normality histogram
          1. Normality
    5. Generated boxM for each demographic group
    6. Changed gender categories to Male and Female/Other
       1. Generated new boxM
18. Levene’s test
    1. levene’s test coding for all chosen variables and multiple transformations
    2. This measures variance of each variable separately, so it is probably not needed
19. Running MANOVA
    1. PACKAGES:
       1. Tidyverse for ggplot, magriterr, etc
       2. Readxl for reading in data
       3. Extrafont to make plots in times new roman
       4. Flextable for flextable() with custom function (allows times new roman)
       5. Car for Manova function
       6. Broom for tidy function
       7. Emmeans for emmeans, emmip, etc.
    2. Loaded chosen\_nona1
    3. Recoded gender to be Male and Female/Other
    4. Ran type III Manova, order gender, race\_eth, age\_group
    5. Ran type I base R manova, order gender, race\_eth, age\_group
       1. Tidied and made into TNR table
    6. Ran type I base R anovas for each chosen measure, order gender, race\_eth, age\_group
       1. Generated tidy tables TNR for each
       2. Depending on significance for each demographic column (if significant):
          1. Generated emmeans table
          2. Tukey pairwise comparisons
          3. Emmeans plot with confidence intervals
    7. Datasets were created
20. Exploring emmeans
    1. PACKAGES:
       1. Tidyverse for ggplot, magriterr, etc
       2. Readxl for reading in data
       3. Extrafont to make plots in times new roman
       4. Flextable for flextable() with custom function (allows times new roman)
       5. Scales for percent in plots
    2. Finish here
21. MANOVA assumptions imputed
    1. PACKAGES:
       1. Tidyverse for ggplot, magriterr, etc
       2. Readxl for reading in data
       3. Extrafont to make plots in times new roman
       4. Flextable for flextable() with custom function (allows times new roman)
       5. Corr for correlate function
       6. Corrplot for corrplot function
       7. Heplots for boxM function
       8. DFA.CANCOR for HOMOGENEITY
    2. Found correlations and generated corrplot
    3. Fit manova model (type I) using base R
       1. Order gender + race\_eth + age\_group
       2. Generated fitted vs. resids plot
          1. Homogeneity of covariances: striations are not concerning, they represent each individual value
       3. Generated QQ plot
          1. Normality
       4. Generated normality histogram
          1. Normality
    4. Generated boxM for each demographic group
    5. Changed gender categories to Male and Female/Other
       1. Generated new boxM
22. Running MANOVA imputed
23. Exploring emmeans imputed