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Sex and Ancestry Estimation Using the Base of the Cranium

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By

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Discriminant function analysis was employed to test sexual dimorphism and ancestral differences in the basicrania of European Americans and African Americans. The data used was originally collected on crania from the Terry and Bass III Donated Collections, using a three-dimensional digitizer. That data was converted to linear data using the method of Franklin et al. (2005). The results showed that sexual dimorphism and ancestral differences do exist in the cranial base of European and African Americans and individuals can be correctly classified at rates ranging from 75% to 80.4%, depending on the analysis.

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Introduction:

Forensic anthropology is defined as "the scientific discipline that focuses on the life, the death, and the post-life history of a specific individual, as reflected primarily in their skeletal remains and the physical and forensic context in which they are emplaced" (Dirkmaat et al., 2008:47). When a forensic anthropologist goes about identifying an individual from their skeletal remains a biological profile is established. The basic components of a biological profile are: sex, age, height, and ancestry. Many times the first thing that is determined is the sex of a given individual. Not only does the identification process begin with the estimation of sex, but other factors such as age or ancestry are much more difficult to assess without first knowing the sex of a given individual (Kimmerle et al., 2008).

There are two types of methods used in sex estimation, metric and non-metric. Non-metric methods utilize visual characters to estimate sex. Metric methods utilize numerical measurements coupled with statistical analysis for estimation. Non-metric methods have their place, and can be very useful if they are used by someone with a very thorough knowledge of the given population or are not the only method employed. Metric methods help remove subjectivity and estimates can be quantified using modern statistical software (Kimmerle, 2008).

A big problem facing forensic anthropologists is the frequent occurrence of fragmentary remains. Many times only a few bones or even a few fragments of bones are recovered and anthropologists are forced to decipher what they can from them (Waldron, 1987). So, there is a constant struggle to find methods that require a small portion of a specific bone that is commonly recovered (Uysal et al., 2005). Many visual methods utilize a small number of or even a single character to assess the sex of a given individual, whereas less subjective, traditional metric methods generally require nearly complete materials. Gunay and Altinkok (2000) said "Every well-trained forensic pathologist or examiner knows the importance of the morphological indicators such as mastoid process, orbital and glabella, but when these parts of the skull are fragmented, subjective morphological evaluation is not always easy." There is a strong need for more metric methods that are applicable to fragmentary remains.

As mentioned above, another important aspect of the biological profile is race/ancestry/population affinity. The skull is considered by many to be the most useful indicator of ancestry (Howells, 1973; Rhine 1993). The estimation of ancestry is a very sensitive area in anthropology (Kennedy, 1995; Ousley et al, 2009). Due to the racist ideals of past anthropologists, modern day anthropologists are forced to tread ever so softly around this subject. Almost every paper written today that discusses race/ancestry has to first rehash the history of race in anthropology (Kennedy, 1995; Ousley et al, 2009). Genetically speaking it is widely accepted that there is more variation within the so-called "races", than there is between them (Nei and Roychoudhury, 1974). That being said there are differences in the skeletal morphology of the people who inhabit this planet (Howells, 1973). The over 7 billion people on the planet inhabit all kinds of different environments. (Kennedy, 1995; Ousley et al, 2009)

Boas (1912) demonstrated so many years ago, our environment plays a role in our morphology by showing that the children of American immigrants showed changes in their cranial morphology from their parents. Ancestry is an important factor in the medicolegal field, forensic anthropology, physical anthropology, and bioarchaeology. In the Medicolegal and forensic anthropology fields, law enforcement agencies want to know the ancestral background of the remains in question. Ousley et al. (2009) does a good job of explaining the difference between "biological race" and "social race". In the bioarchaeology and physical anthropology fields, it is of great importance to find out what known populations, the remains in question most closely resemble because anthropologists have shown that similar cranial morphology suggests a similar geographic background (Ousley et al, 2009).

Ancestry identification, not unlike sex identification, is generally carried out using simple non-metric subjective characters like "dental arcade shape", or "facial prognathism" (Texiera, 1982). To be able to confidently yield these methods one needs long and varied experiences with multiple osteological collections or perhaps long and varied experiences with the population that will be studied (Bruzek, 2002). A forensic anthopologist in Montana would want to have a very thorough knowledge of European Americans and Native Americans. These are the mostly likely groups to wind up in a medicolegal or archaeological context in Montana (U.S.Census Bureau, 2010a). A forensic anthropologist working around New York City would need a much more vast knowledge of different populations due to the amount of diversity in that area (U.S. Census Bureau, 2010b). This creates a problem for today's forensic anthropologist, because as the ease of global travel begins to bring people from all different parts of the world together, our access to osteological materials is shrinking. Many universities lack sufficient materials for their students to gain a perspective of the vast amount of diversity in our species (Kennedy, 1995). Due to the lack of real materials these universities turn to casts or plastic replicas'. Anyone who has studied osteology or anatomy with only a book and some casts and then studied real bone or a cadaver knows that there is no replacing the real thing (Kennedy, 1995). You simply cannot get the same amount of detail out of a cast. On top of that, when you only have a limited amount of specimens, students will be forced to accept them as the "norm" for that population (Kennedy, 1995).

Using a discriminant function created from African and European Americans from the Terry Collection to determine the sex on a specimen that was found in Tokyo, would not yield confident results (Ramsthaler et al, 2007). It is also important to understand that when someone uses the Terry Collection for a study on ancestry estimation, that when they conclude that someone is of African American decent, that it does not simply mean African. All that can be stated is that this person shows characteristics common in African Americans. To say that someone is simply African is absurd. Africa is made up of several countries making probably the most climatically diverse continent on the planet. There is more genetic diversity in Africa than any other place in the world (Tishkoff et al, 2009). So, just because someone is familiar with the cranial morphology of African American's does not mean that they know much about the skeletal morphology of all African's (Kennedy, 1995). The way to combat this problem is for more metric studies to be done and for the data used to be made public. With the internet at our disposal people can access information from all over the world from their computers. The FORDISC program (Jantz and Ousley, 1993) is a combination of the Forensic Data Bank, the Howells cranial data set, and discriminant function analysis. Anyone who has paid for the software can plug in measurements from the cranial or post-cranial bones and get a prediction of sex, race, and stature of the individual in question. New and updated versions are created and added as more information is acquired. Newer and updated versions have allowed for a sample reflective of people born after 1930. As long as the measurements are recorded correctly this program can be used by most anyone (Adams and Byrd, 2002).

McKeown and Wescott (2010) gave a presentation at the American Association of Forensic Science Conference on their proposed method for predicting ancestry and sex among African and European Americans. McKeown and Wescott (2010) used an electronic digitizer to record 3-dimensional landmarks located on the base of the cranium. Those 12 landmarks were subjected to a general procrustes analysis to bring them onto the same coordinate system. The fitted coordinates were then run through a principle components analysis. Then they used their newly acquired principle components combined with the Centroid Size derived from the procrustes analysis as their discriminant functions. The results achieved were a classification rate of 85.7% for sex, with males being misclassified more than females, and 85.14% for ancestry with both African and European Americans showing an almost equal classification rate. Their classification of ancestry achieved higher results when shape alone was used. Higher results for the estimation of sex required size and shape. This suggests that shape is a very important component to ancestral differences between European and African Americans. Their results suggest that this is a very successful method for sex and ancestry classification.

In this analysis I will be converting the 3-dimensional data from McKeown and Wescott (2010) into linear form. By doing this I will make this method available to people who do not have access to an electronic digitizer. It is well known that linear distances can be derived from three-dimensional coordinates (Franklin et al., 2005). After converting the data I will use a discriminant function analysis for sex and ancestry.

My hypothesis is that I will obtain classification results using discriminant functions on interlandmark distances of the basicranium that are better than chance. If this is true, then my results will demonstrate that this area of the skull provides a useful method of determining the sex and ancestry of severely fragmented crania.

By doing this study I can address three major needs in the forensic anthropology world. First, I will be adding to the research of a newer metric method of assessing the sex and ancestry of a given skeleton. Second, that method will be usable for crania of juveniles and adults (Veroni et al, 2010). Third, this analysis helps solve the need for methods that work on fragmentary remains (Gapert et al, 2009a).

Literature Review:

The Study of the Cranium

Many anthropologists have concentrated on the cranium in their methods for distinguishing sex (e.g. Giles & Elliot, 1963; Holland, 1986: Catalina-Herrera, 1987; Uysal et al., 2005; Veroni et al., 2010). It has been stated that "next to the pelvis, the skull is the most easily sexed portion of the skeleton" (Giles, 1964), but Spradley and Jantz (2011) have cast some doubt on this long held belief. It has also been stated that the skull "provides more indication of race than any other skeletal part" (Giles and Elliot, 1962). The basal area of the skull is protected by many layers of soft tissue (Gapert et al., 2009a), and develops very early in age (around 8 years old [Tillmann and Lorenz, 1978]). Also there are no muscle attachments in the area that would cause continued growth (Gapert et al., 2009a). Theoretically sex and ancestry should be very distinguishable for a very wide age range.

Giles and Elliot (1963) obtained 9 measurements from 408 known sex American White and American Black crania from the Todd Collection. The Todd Collection consists of low socio-economic status individuals from St. Louis, MO, and Cleveland, OH. These measurements were used in 21 combinations to form discriminant functions for sex determination. The authors achieved a prediction rate of 82-89%. The authors used 75 specimens from each race and sex (75 white males, 75 white females, 75 black males, 75 black females). The rest of the individuals were used as a test sample. All specimens used fell within the age range of 21 to 75 years of age. The measurements used were *Glabello-occipital length, Maximum width, Basion-bregma height, Basion-nasion, Maximum diameter bi-zygomatic, Basion-prosthion, Prosthion-nasion height,* *Palate-external breadth,* and *Mastoid length* (Hooton, 1946). After the results from their study were done the authors wanted to test their method on other populations. The authors were able to correctly determine the sex of 85 adult chimpanzees 89.4% of the time. The authors then applied their function to an Irish population. Of the 200 individuals only 42 males and 12 females had the required measurements. This sample comes from 200 skeletons that were uncovered, examined, and reburied in 1935. The results of this study were published by W.W. Howells (1941). Of the individuals used, the males produced a classification rate of 95% and the females 25%. The authors made mention that Howells did admit that he was not fully confident in his female predictions due to the small amount of remains available for his assessment. The final group that the authors applied their method consisted of 3 American Indian populations (Indian Knoll, Pecos Pueblo, Florida). The Indian Knoll and Pecos Pueblo populations yielded results from 76.9 to 91.9%. The Florida population results were less impressive yielding results from 64.4 to 70%. The Indian populations were not of known sex but there was better than average data concerning the probable sex, according to the authors.

Giles (1964) did a study on the sexual dimorphism of the mandible using nine measurements and discriminant function analysis. The measurements used were taken from Stewart, (1952). His sample consisted of 265 mandibles from the Terry collection. With a total of 75 African American males, 75 African American Females, 31 European American males, and 30 European Females, all between the ages of 21 to 75 years. Only a remaining group of 27 African American males and 27 African American Females were used as a test sample. Number's 1-3 of the discriminant functions utilize only three measurements (*Mandibular Symphysis height, Mandibular ramus height, Bigonial diameter*), number's 4-6 of the discriminant functions utilize five measurements (Mandibular symphysis height, Mandibular body height, Mandibular body length, Mandibular ramus height, Bigonial diameter), and numbers 7-9 of the discriminant functions utilize 6 measurements (*Mandibular symphysis height, Mandibular body length, Mandibular body thickness, Mandibular ramus minimum breadth, Mandibular ramus maximum breadth, Mandibular ramus height*), but only require only one half of the mandible. The results showed a correct estimation rate for sex of around 85%.

Birkby (1966) did a study to test the reliability of the methods proposed by Giles and Elliot (1963). The sample consisted of 104 adult crania (95 American Indian males and females, 9 Labrador Eskimo males). Measurements used were *Glabello-Occipital length, Bizygomatic diameter, Basion-Prosthion length, Basion-Nasion length, Prosthion-Nasion height, Basion-Bregma height, Cranial width, Nasal breadth*. These measurements were applied to the functions created by Giles (1962). The results of the discriminant function analysis were compared to visual method predictions. The results of the discriminant analysis for ancestry and sex were at both ends of the spectrum. The Indian Knoll population classified very well because it was involved in creating the original function. The authors conclude that discriminant analysis should not be used on a single specimen case. Only discriminant functions created from the population to which the specimen is thought to belong should be used.

Kajanoja (1969) did a study on the sexual dimorphism of the cranium combining eight measurements with a discriminant function analysis. The measurements used were *Maximum width, Maximum bi-zygomatic diameter, Glabello-Occipital length,* *Basion-Bregma height, Basion-Prosthion, Basion-Nasion, Prosthion-Nasion height,* and *Nasal breadth* (Hooton, 1946). The sample included 232 Finnish crania comprised of 165 male and 67 female adults. Two discriminant functions were created. The first included all eight measurements and the second included five of the eight measurements (*Maximum bi-zygomatic diameter, Gabello-Occipital length, Basion-Prosthion, Basion-Nasion*, and *Prosthion-Nasion height)*. The measurements chosen for the latter function correspond to one of the functions from Giles and Elliot (1963). The overall classification results for sex determination using all eight measurements were 79.5%. The classification results for the Giles and Elliot (1963) discriminant function were only 65%. These results were very curious because Giles & Elliot, (1963), were able to use this function on three Native American populations and a sample of Chimpanzees, and were able to come up with better classification rates.

Teixeira (1982) did a study on the sexual dimorphism of the foramen magnum. It is important to note that Teixeira is a Medical Examiner and his purpose for the study was to develop a method that would be quantifiable and work well with fragmented remains when an expert in forensic anthropology or crime laboratory is not available. The foramen magnum had already been shown to be sexually dimorphic by Fatteh (1973). The sample used consisted of 40 exhumed skeletons (20 male, 20 female) from the City House. The age range was 18 to 83 years. The author calculated the area by using the medium value between the half measures of the length and width of the foramen magnum. The median value for all males was 963.73 mm^2 +/- 140 and for all females was 805.65 mm^2 +/- 105. These results corresponded with those of Fatteh (1973). Teixeira acknowledges that even though his study shows that males have larger foramen magna than females, his sample size is far too small to make such an allegation and a larger sample size needs to be tested.

Holland (1986b) did a study on the cranial base in hopes to find a useful method for sexing fragmentary crania. His sample consisted of 100 crania from the Terry Collection. Of those 100, 25 white males, 25 white females, 25 black males, and 25 black females, all between the ages of 20 and 50. Nine measurements were taken from each cranium. These measurements included *Maximum length of condyle, Maximum width of condyle, Length of foramen magnum, Width of foramen magnum, Distance between postcondyloid foramina, Minimum distance between condyles, Bicondylar breadth, Maximum interior distance between condyles,* and *Length of basilar process.* Using linear discriminant function analysis, the authors were able to correctly predict sex 71-91% of the time. The best results came when all measurements were used. *Maximum width of condyle*, seemed to be the most significant measurement in the discriminant function. Twenty individuals, not included in the original analysis were used as a control group and were correctly sexed 70-85% of the time. Although the numbers in Holland's study are not as impressive as Giles and Elliot's (1963), his study might prove more useful due to the fact that it can be employed on fragmentary and deformed crania.

Earlier in this same year Holland (1986a) did a study utilizing 8 measurements on the same 100 crania, to see if race could be deciphered. The measurements included were *Length of occipital condyle*, *Width of occipital condyle*, *Minimum distance between condyles*, *Maximum distance between condyles*, *Maximum interior distance between condyles*, *Length of foramen magnum*, *Width of foramen magnum*, and *Length of the* *basilar process*. Using multiple regression analysis, Holland was able to correctly classify race 70-86% of the time. When tried on a control sample of 20 crania, the results showed 75-90% accuracy. The best discriminant function used six of the eight measurements (*Length of occipital condyle, Minimum distance between condyles, Maximum distance between condyles, Maximum interior distance between condyles, Width of foramen magnum*, and *Length of basilar process)* (Holland, 1986a).

Catalina-Herrera (1987) showed that the width, length, and overall shape of the foramen magnum demonstrate different sizes between males and females. The study consisted of 100 specimens (74 male, 26 female), between the ages of 20 and 70 years. The results showed that the mean area in males was 888.4 mm^2, and 801 mm^2 in females. The maximum sagittal and transverse diameters were 42 and 36 mm in males, 39 and 33 mm in females. In conclusion the foramen magnum in males is larger than in females in the population studied. These numbers do not quite line up with those of Teixeira (1982). The females overall area is only about 4.5 mm^2 smaller but the males is around 75 mm^2 smaller. There are two possibilities for these differences. First, Teixeira's sample consisted of 40 crania, whereas Catalina-Herrera's consists of 100 crania. Second, the Teixeira (1982) sample population was from Chile and Catalina-Herrera's was from Spain. The important thing is that both studies can say that on average the foramen magnum is larger in males than in females.

Iscan and Steyn (1999) set out to "develop discriminant function formulae to determine race from craniometric dimensions of South African Blacks and Whites" (Iscan and Steyn, 1999:91). Their sample consisted of the skull of 53 White males, 53 White females, 45 Black males, and 45 Black females. They used 13 standard cranial measurements and 4 mandibular measurements. The cranial measurements included: *Cranial length, Cranial breadth, Maximum frontal breadth, Minimum frontal breadth, Bizogomatic breadth, Basion-Nasion, Basion-Bregma, Basion-Prosthion, Nasion-Prosthion, Mastoid height, Biasteronic breadth, Nasal height,* and *Nasal breadth*. The mandibular measurements included: *Bicondylar length, Bicondylar breadth, Bigonial breadth,* and *Minimum ramus breadth*. The results of the discriminant function analysis showed that the cranium demonstrates much higher degree of separation between the two groups. The authors were able to achieve cross-validated classification results of around 94%. The measurement of *Basion-Prosthion* played a very significant role in these results. The authors attempted to use the Giles and Elliot (1962) formulae on their sample and received poor classification results. The authors attribute this to the importance of using discriminant functions for race only on the populations that they are derived from.

Gunay and Altinkok (2000) set out to do a follow up on the method used by Fatteh (1973), Teixeira (1982), and Catalina-Herrera (1987). The sample population used were Turkish adults (18 years and older) consisting of 170 males and 39 females. The same measurements were taken as the previous studies mentioned. The average area of the foramen magnum in males was 909.91 mm^2 and 819.1 mm^2 in females. Although the male area was a little closer to Teixeira's result it is still much smaller. The females showed a slightly larger area than Teixeira's result. In both Teixeira (1982) and Catalina-Herrera (1987) a larger amount of male crania were measured and the result was a lower average area. This could be a product of two different populations or maybe Teixeira's small amount of male crania had an un-proportional amount of individuals with larger foramen magnum. Female average area stayed relatively close in all three studies but then again there was never a very large amount females included in any of them. To get a better feel for this method a follow up study should be done using a larger sample size for any of these three populations.

Wescott and Moore-Jansen (2001) composed a study for the purpose of investigating the reliability of sex and ancestry estimation when utilizing the condylar region of the occipital bone, and the effects of age and ancestry when estimating sex. Their study was based on the methods developed by Holland (1986a, 1986b). Their sample population consisted of 389 white and 133 black adult crania (20-80 years of age) from the Terry and Hamann-Todd anatomical cadaver collections. Ten measurements were used in accordance with the definitions given by Holland (1986a, 1986b). The statistical analysis used included a MANOVA and a discriminant function analysis. The authors ran into high intra-observer error with a few of the measurements which they attribute to Holland changing the definitions of measurements and the lack of the condylar foramen in many individuals. Their classification results from their discriminant function analysis for sex yielded a prediction rate of 76% with females being classified correctly more often than males. Their classification results from their discriminant function analysis for ancestry yielded a prediction rate of 75% with whites being classified correctly more often than blacks. The authors concluded that measurements of the occipital are difficult to replicate but their greatest concern was the inconsistencies in the measurements taken by Holland. They also concluded that age does not have any apparent effect on the estimation of sexual dimorphism in the basiocrania. They suggest that although this method provides a moderately successful way of estimating sex and ancestry with fragmentary crania, it should be used with caution.

Uysal et al. (2005) used CT scans of the basiocrania to attempt to estimate sex. The sample consisted of 100 individuals (48 males, 52 females). The study utilized seven separate measurements that revolved around the foramen magnum and the occipital condyles. Although all dimensions were larger in males, there was a statistically significant difference in the overall length and width of the right occipital condyle and the width of the foramen magnum. Using discriminant function analysis, the authors were able to correctly estimate sex 81% of the time. We all know that sample skeletal materials are very scarce and that the human population only seems to grow, therefore if we could jump start more of these studies we could really gain in a vast amount of material and be able to get populations that until now have not been thoroughly studied. The problem is that CT scans are anything but cheap, and for that reason I am afraid that the use of CT scans in physical anthropology will probably remain limited.

Franklin et al. (2005) did a study aimed at examining sexual dimorphism in Bantu-speaking South African crania. The sample population consisted of 332 adult crania (182 male, 150 female) from the R.A. Dart Collection of Human Skeletons. The sample consists of three major Bantu-speaking subgroups, the Natal Nguni, the Cape Nguni, and the Sotho. The eight cranial measurements used were taken from Giles and Elliot (1963). They had to be calculated from 3-dimensional landmarks that were collected with an electronic digitizer for a later study. The authors calculated the linear measurements from the 3-dimensional landmarks by way of the Pythagorean Theorem.

When employing discriminant function analysis Franklin's method produced an estimation rate of 80%. When they applied the discriminant function produced by Giles and Elliot (1963) they achieved an estimation rate of 70% and even after recalculating the sectioning point it was only improved to 75%. This study was very important because it further tested Giles and Elliot (1963).

Kimmerle et al. (2008) did a study using 3-dimensional data collected on 16 standard craniofacial landmarks from the W.M. Bass Donated Collection and the Forensic Data Bank. The sample population consisted of 118 American White and Black males and females. The authors started by performing a generalized Procrustes analysis to bring all of the specimens into a common coordinate system. Next, all of the specimens were scaled to unit Centroid Size. Centroid Size was used because it is the only size measure that is uncorrelated with shape variation for small, random, spherical variation at the landmarks (Bookstein, 1991). Then, using MANCOVA the authors were able to deduce that smaller and larger individuals of the same sex are similar in shape and that sex does have a significant influence on shape in both American Whites and Blacks. They also note that the Centroid Size for each group was higher in males (i.e. males are larger). Though discriminant function analysis the authors showed that by using the shape variables coupled with the centroid size the estimation percentage was greatly increased and that in American Whites when size and shape are used that males are misclassified more than females but when shape alone is used the females are misclassified more than the males. This article showed that at least on the sample utilized that 3-dimensional data is a source of greater detail than traditional linear measurements and by harnessing this greater detail one can better decipher the sex of a given individual.

Gapert et al. (2009a) did a study on the sexual dimorphism in the foramen magnum of adult individuals. The sample consisted of 158 British adults (82 males, 76 females) 18 years and older, from the St. Brides Church collection. The measurements used were the same as Holland (1986a). The measurements taken were coupled with a discriminant function analysis. The authors chose to focus on the foramen magnum for two reasons. First, it is a heavily protected area and tends to hold up in the archaeological record. Second, it houses the medulla oblongata and as the nervous system is probably the bodies most precarious of systems it develops early. The most reliable variable for sex determination was the width of the foramen magnum or *WFM* which gave a prediction rate of 65.8%. The best combination of variable was the width of the foramen magnum + the area of the foramen magnum or *WFM* + *FMC* which gave a prediction rate of 70.3%. When the means of all the measurements were compared to Turkish and Spanish populations they were quite similar. The authors state their intention to do a follow up study concentrating on the occipital condyles and then maybe a conjunction of the two. The second article looking at the occipital condyles increased the prediction rate to 76.7%. The authors close by stating that although significant differences are shown between the two sexes that do to the less than absolute results this method should be readily used when only fragmented remains are at hand but not if there is a more complete specimen that can analyzed with a more thorough method.

Ousley et al. (2009) attempted to show that European and African Americans can be classified into their correct ancestral groups using craniometrics and a discriminant function analysis. Their sample consisted of 365 individuals from the Forensic Data Bank of either African or European American descent. Using only two measurements they were able to correctly classify each group 80% of the time and when using 19 measurements they were able to correctly classify each group 97% of the time. The success of the study was twofold. Not only did it demonstrate once again the effectiveness of the use of discriminant function analysis in conjunction with linear measurements but it also dives head first into the battle of differentiating the social construct of race and the differences in skeletal morphology in different populations.

Sexual dimorphism in juveniles is a heavily studied area in physical anthropology. Many studies have been done on the amount of sexual dimorphism in juveniles (Reynolds, 1945, 1947; Boucher, 1955; Hunt and Gleiser, 1955; Black 1978; Weaver, 1980; Rosing, 1983; Schutkowski, 1987, 1993; De Vito and Saunders, 1990; Holcomb and Konigsberg, 1995; Molleson et al., 1998; Loth and Henneberg, 2001). Veroni, et al. (2010) did a study to assess the sexual dimorphism of the foramen magnum and occipital condyles in juveniles. The area was chosen because it has been shown that following rapid brain growth, the posterior cranial fossa reaches adult dimensions around 8 years of age (Redfield, 1970; Tillman and Lorenz, 1978). The 36 specimens used in this study ranged from 8 to 19 years of age. Using 5 basiocranial measurements and discriminant function analysis the authors were able to estimate the correct sex 75.8% of the time. This is lower than previous studies with adults (Teixeira, 1982; Holland, 1986; Catalina-Herrera, 1987; Gunay and Altinkok, 2000; Uysal et al., 2005) but the authors attribute that to population variability rather than the age of the individuals studied.

Spradley and Jantz (2011) conducted a study that utilized the skull and post-cranial bones to estimate sex. They used 24 cranial, 10 mandibular, and 44 postcranial measurements (Moore-Jansen et al., 1994). There sample consisted of : skull (71, African American females, 107 African American males, 203 European American females, 323 European American males), post-cranial (51 African American females, 92 African American males, 185 European American females, 311 European American males). All individuals were from the Forensic Data Bank and born after 1930 so that they could encompass an age range that represents recent forensic cases in the United States. Using discriminant function analysis the authors were able to show cross-validated classification results of 90-91% for the cranium and up to 94% using post-cranial bones. This study clearly suggests that more studies need to concentrate on metric analysis of the post-cranial skeleton.

Materials and Methods:

Sample

The sample consists of 276 individuals (81 black males, 92 white males, 52 black females, 51 white females); from the Terry collection and the Bass donated collection. The Terry collection represents St. Louis, MO, residents of African and European American descent, from the early to mid-20th century, from low to middle socioeconomic backgrounds. The Bass Donated collection is mostly represented by European Americans from the Southeastern United States, born after 1940.

Data

With the help of Dr. Ashley McKeown I chose 11 measurements to take the place of the twelve 3-dimensional landmarks that she collected and which constituted the data used by McKeown and Wescott (2010). The eleven measurements that will be used in the analysis are *Basion-Opisthion, FML-FMR, Hormion-basion, Basion-FML, Basion-FMR, Opisthion-FML, Opisthion-FMR, Basion-mastoidL, Basion-mastoidR, Opisthion-mastoidL, and Opisthion-mastoidR*. For definitions of these landmarks please refer to Table 1.

I will first be converting all of the coordinate data taken with the digitizer into linear data. The data of McKeown and Wescott (2010) was provided to me in Microsoft Excel format. Each 3-dimensional landmark had 3 coordinates. To calculate my linear measurements from these 3-dimensional landmarks I used a simple equation on excel. The landmarks were collected in the form of 3-dimensional coordinates (x, y, z). The 3-dimensional coordinates were converted to linear distances by the Pythagorean formula: $SQR[(x_1-x_2)^2+(y_1-y_2)^2+(z_1-z_2)^2]$, where x_1-x_2 is the x coordinate difference between any two landmarks, and x, y and z are the 3-dimensional landmark coordinates (Franklin et al., 2005). This was carried out for all 11 measurements on all 276 individuals.

After all of my data was converted I analyzed it using SPSS 17 where I labeled the sex for female as "2" and the sex for male as "1". For ancestry I labeled the European Americans as "4" and the African Americans as "3". Coding these categorical variables as integers is required by the discriminant function procedure in SPSS. For many years in the forensic sciences it has been widely accepted that the use of discriminant function analysis of measurements to assist in the estimation of sex and ancestry of human remains is a very productive method (e.g. Giles and Elliot, 1962; Steel, 1962; Giles, 1964; Hanihara et al., 1964). A discriminant function analysis can be defined as a statistical analysis to predict a categorical dependent variable by one or more continuous or binary independent variables (Poulsen and French, n.d.). It is useful in determining whether a set of variables is effective in predicting category membership. My first analysis was a discriminant function analysis for sex classification using all individuals and selecting for "equal prior probabilities".

In order to investigate the effectiveness of these measurements for estimating ancestry, I did a discriminant function analysis for ancestry by using race as my grouping variable. Next, I ran a discriminant analysis for sex using each race individually. All results were cross-validated with the "leave one out" method.

Last, I did a discriminant function analysis for sex and ancestry without size. This was accomplished by running a principal components analysis and choosing to save the significant principal components and then not using the size component in my discriminant function analysis. Principal Components Analysis is a mathematical tool used to reduce the number of variables while retaining the original variability of the data (Wold et al., 1987). The principal component representing size was the component that reflected the most of the variance in the data.

Table 1: Landmark Descriptions

Basion (B)	The point where the anterior margin of the foramen magnum is intersected by the mid-sagittal plane. (Martin1956:446)
Opisthion (O)	The point at which the mid-saggital plane intersects the posterior margin of the foramen magnum. (Martin1956:446)
Foramen Magnum Left (FML)	Point of greatest lateral curve of left side of foramen magnum.
Foramen Magnum Right (FMR)	Point of greatest lateral curve of right side of foramen magnum.
Mastoid Left (MastL)	Lateral edge of tip of left mastoid.
Mastoid Right (MastR)	Lateral edge of tip of right mastoid.
Hormion	Point of union of the sphenoid bone with the posterior border of the vomer. (Saunders, 2007)

RESULTS:

Tables 2, 4, 6, and 8 display the Standardized Canonical Discriminant Function Coefficients. These values can be used to understand which measurements were most significant in creating the discriminant function. The higher the number, the higher the significance of said measurement whether it is a negative or positive number. In tables 2, 4, 6, and 8 the three most significant measurements are underlined.

Tables 3, 5, 7, 9, 10, and 11 display the classification results. Each table displays the number and percentage of the correctly and incorrectly classified individuals. Tables 3, 5, 7, and 9 also display "cross-validated" results. Cross-validation is done only for those cases in the analysis. In cross-validation, each case is classified by the functions derived from all cases other than that case. Tables 10 and 11 display the classification results for sex and ancestry without size. The results were not cross-validated because the classification rates were so low.

Tables2 and 3 represent the discriminant function analysis for sex using only African Americans. Tables 4 and 5 represent the discriminant function analysis for sex using only European Americans. Tables 6 and 7 represent the discriminant function analysis for sex using both European and African Americans. Tables 8 and 9 represent the discriminant function analysis for ancestry.

Discriminant Function Analysis for Sex-African Americans

Table 2: Standardized Canonical Discriminant Function Coefficients

B-O	-.167
FML-FMR	-.422
H-B	.124
B-FML	.254
B-FMR	.245
O-FML	.382
O-FMR	.249
B-MastL	.369
B-MastR	.181
O-MastL	-.037
O-MastR	.471

Table 2 shows the measurements that were most significant in the function for classifying correct sex in African Americans. The most significant measurements were O-MastR, FML-FMR, and O-FML. The least significant measurement was O-MastL

Table 3: Classification Results

1="male" **2="female"**		**Predicted Group Membership**		**Total**
		1	**2**	
Original Count	1	65	16	81
	2	8	44	52
Percent	1	80.2	19.8	100.0
	2	15.4	84.6	100.0
Cross-Validated Count	1	60	21	81
	2	9	43	52
Percent	1	74.1	25.9	100.0
	2	17.3	82.7	100.0

Table 3 shows the classification results for sex prediction in African Americans. The results for classification were 82%. The males were correctly classified 80.2% of the time and the females were correctly classified 84.6% of the time. The cross-validated results were 77.4%, with the males being incorrectly classified more often than the females

Discriminant Function Analysis for Sex in European Americans

Table 4: Standardized Canonical Discriminant Function Coefficients

B-O	-.499
FML-FMR	-.448
H-B	.117
B-FML	-.139
B-FMR	.704
O-FML	.165
O-FMR	.336
B-MastL	.507
B-MastR	.285
O-MastL	.335
O-MastR	.201

Table 4 shows the measurements that were most significant in the function for classifying correct sex in European Americans. The most significant measurements were B-FMR, B-MastL, and B-O. The least significant measurement was H-B

Table 5: Classification Results

1="male" **2="female"**		**Predicted Group Membership**		**Total**
		1	**2**	
Original	1	77	15	92
Count	2	4	47	52
	1	83.7	16.3	100.0
Percent	2	7.8	92.2	100.0
Cross-Validated	1	75	17	92
Count T	2	7	44	52
a	1	81.5	18.5	100.0
Percent T	2	13.7	86.3	100.0

Table 5 shows the classification results for sex prediction in European Americans. The overall classification results were 86.7%. The males were correctly classified 83.7% of the time and the females were correctly classified 92.2% of the time. The cross-validated results were 83.2%, with the males being incorrectly classified more often than the females.

Discriminant Function Analysis for Sex in European and African Americans

Table 6: Standardized Canonical Discriminant Function Coefficients

B-O	-.252
FML-FMR	-.472
H-B	.133
B-FML	.022
B-FMR	.455
O-FML	.213
O-FMR	.269
B-MastL	.453
B-MastR	.255
O-MastL	.140
O-MastR	.332

Table 6 shows the measurements that were most significant in the function for classifying correct sex in both European and African Americans. The three measurements that were most significant were FML-FMR, B-FMR, and B-MastL. The least significant measurement was B-FML.

Table 7: Classification Results

1="male" 2="female"		Predicted Group Membership 1	Predicted Group Membership 2	Total
Original	1	140	33	173
Count	2	15	88	103
	1	80.9	19.1	100.0
Percent	2	14.6	85.4	100.0
Cross-Validated	1	136	37	173
Count T	2	17	86	103
T	1	78.6	21.4	100.0
a Percent b	2	16.5	83.5	100.0

Table 7 shows the classification results for sex prediction in both European and African Americans. The overall classification results were 82.6%. The males were correctly classified 80.9% of the time and the females were correctly classified 85.4% of the time. The cross-validated results were 80.4%, with the males being incorrectly classified more often than the females.

Discriminant Function Analysis for Ancestry

Table 8: Standardized Canonical Discriminant Function Coefficients

B-O	-.138
FML-FMR	-1.429
H-B	.460
B-FML	-.129
B-FMR	.627
O-FML	.306
O-FMR	.809
B-MastL	.501
B-MastR	.056
O-MastL	-.435
O-MastR	-.386

Table 8 shows the measurements that were most significant in the function for classifying correct ancestry. The three most significant measurements were FML-FMR, O-FMR, and B-FMR. The least significant measurement was B-MastR.

Table 9: Classification Results

3="black" 4="white"		Predicted Group Membership		Total
		3	4	
Original Count	3	100	33	133
	4	28	115	143
Percent	3	75.2	24.8	100.0
	4	19.6	80.4	100.0
Cross-Validated Count a	3	96	37	133
	4	32	111	143
b Percent a	3	72.2	27.8	100.0
	4	22.4	77.6	100.0

Table 9 shows the classification results for ancestry prediction. The overall classification results were 77.9%. African Americans were correctly classified 75.2% of the time and European Americans were correctly classified 80.4% of the time. The cross-validated results were 75%, with the African Americans being incorrectly classified more often than the European Americans.

Discriminant Function Analysis for Sex without Size

Table 10: Classification Results

1="male" **2="female"**		**Predicted Group Membership**		**Total**
		1	**2**	
Original	1	113	60	173
Count	2	37	66	103
	1	65.3	34.7	100.0
Percent	2	35.9	64.1	100.0

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Table 10 shows the classification results for sex prediction in both European and African Americans with size removed. The overall classification results were 64.9%. The males were correctly classified 65.3% of the time and the females were correctly classified 64.1% of the time.

Discriminant Function Analysis for Ancestry without Size

Table 11: Classification Results

3="black" **4="white"**		**Predicted Group Membership**		**Total**
		3	**4**	
Original Count	3	85	48	133
	4	46	97	143
Percent	3	63.9	36.1	100.0
	4	32.2	67.8	100.0

Table 11 shows the classification results for ancestry with size removed. The overall classification results were 65.9%. European Americans were correctly classified 67.8% of the time and African Americans were correctly classified 63.9% of the time

Discussion:

In my results section I have included the "Classification Results Table" and "Standardized Coefficients Table" from each analysis except for the two with the size component removed which only include the "Classification Results Table".

Table 2 shows the standardized coefficients for the discriminant function analysis for sex in African Americans only. The three most significant measurements in the function for sex prediction were O-MastR, FML-FMR, and O-FML. Table 3 shows that the classification rate for sex determination was 82% with the males being misclassified more than the females, similar to Wescott and Moore-Jansen (2001). The cross-validated results bring it down to 77.4%.

Table 4 shows the standardized coefficients for the discriminant function analysis for sex in European Americans only. The three most significant measurements in the function for sex prediction were B-FMR, B-MastL, and B-O. Table 5 shows that the classification rate for sex determination was 86.7% with the males being misclassified more than the females, again similar to the results of Wescott and Moore-Jansen (2001). The cross-validated results bring it down to 83.2%. Classification rates for sex estimation were more successful with European Americans than African Americans.

Table 6 shows the standardized coefficients for the discriminant function analysis for sex using both races. This shows that the most important variables in the function for sex prediction were FML-FMR, B-FMR, and B-MastL. Two of these three were also the most important when European Americans were classified alone (B-FMR, B-MastL). FML-FMR was one of the most important measurements for African Americans when classified alone. It is not surprising to see that FML-FMR (or transverse diameter of the foramen magnum) is one of the most important measurements in sex classification as Uysal et al. (2005) showed that next to the right occipital condyle it was the most sexual dimorphic trait. B-FMR could have a correlation to the size of the right occipital condyle which would explain its importance (Uysal et al., 2005). Table 7 shows the cross-validated classification results for sex determination using both races was 80.4%. The males were misclassified more than the females. This corresponds with the findings of (Wescott and Moore-Jansen., 2001; McKeown and Wescott, 2010). This suggests that more males fall into the female size range for measurements than vice versa. This can be stated confidently because when size was removed the females were misclassified more than the males (Table 10).

Table 8 shows the standardized coefficients from the discriminant function analysis for ancestry. This table shows that the top three most important variables to the function for ancestry prediction are FML-FMR, O-FMR, and B-FMR. So, two of the most important measurements for determining sex using both races are also the most important for differentiating between those two races. FML-FMR being the most significant measurement in determining ancestry corresponds with Holland (1986a). Table 9 shows the cross-validated classification results for ancestry prediction were 75% with African Americans being misclassified more than European Americans. The higher rate of misclassification of African Americans corresponds to Wescott and Moore-Jansen (2001). I am somewhat disappointed in this result because I was expecting 80% or above.

One interesting thing to note is the importance of certain variables in predicting the dependent (sex), for the different races. You will notice in the results section under the heading for European Americans the most important variables were B-FMR, B-MastL, and B-O (Table 4), and then under the heading for American Blacks the most important variables are O-MastR, FML-FMR, and O-FML (Table 2). So, The three most important measurements for determining sex in European Americans are completely different from the three most important measurements for determining sex in African Americans. The two measurements that I used that correspond to the foramen magnum are B-O (Saggital diameter) and FML-FMR (Transverse Diameter). So, I can confidently say that although the foramen magnum was critical in the analysis, only the saggital diameter or B-O was so for European Americans and only the transverse diameter was so for African Americans. Tables 3 and 5 demonstrate that this method is superior at predicting sex in European Americans than African Americans.

In all but the discriminant function for sex in European Americans alone, the measurement of FML-FMR or the transverse diameter of the foramen magnum was one of the top three most significant measurements in the discriminant function. This shows that not only is the width of the foramen magnum a reliable sexual dimorphic trait but that it is also a population specific trait.

. Tables 10 and 11 show the classification results for discriminant function analysis done for sex and ancestry without the size component. I wanted to see if there was a significant shape component to the sexual dimorphism in the basiocrania. Finding a difference in shape would be very exciting for sexual dimorphism in juveniles because the size factor would not come into play. As you can see from the classification tables my prediction results were not very strong and I am afraid that size is a necessity. It is important to note that these results showed that when size alone is used that unlike the results with size included, the females are misclassified more than the males. This confirms the results of Kimmerle et al., (2008).

Conclusions:

The McKeown and Wescott (2010) discriminant function analysis for sex included all individuals of both races and achieved a prediction rate of 85.7%. My discriminant function analysis for sex using both populations had a prediction rate of 82.6% and when cross-validated to 80.4%. The McKeown and Wescott (2010) discriminant function analysis for race yielded a prediction rate of 85.14% and mine achieved a prediction rate of 77.9% and when cross validated to 75%. The classification accuracies I obtained were less than those obtained by McKeown and Wescott (2010), who used more variables and included variables of the palate in their analysis. Given that my analysis used fewer variables and did not include the palate my results are reasonably similar. My classification results are substantial enough to be utilized as a method for sex estimation and ancestry from the cranial base of European and African Americans. The McKeown and Wescott (2010) 3-dimensional method and my linear method have demonstrated to be useful for the prediction of sex and ancestry for European and African Americans.

My prediction rate for sex when all individuals are included yielded comparable results to (Giles and Elliot 1963; Holland, 1986b; Franklin et al., 2005; Uysal et al., 2005; Veroni et al., 2010; Gapert et al., 2009a; Gapert et al., 2009b). My 11 measurements coupled with a discriminant function analysis can be confidently utilized when attempting to sex an individual from the basiocranium. Although my results for sex classification were not as high as McKeown and Wescott (2010), they were more comparable than my results for ancestry estimation because as McKeown and Wescott (2010) suggested, size is more important than shape when it comes to sex. The addition of a measurement that takes into account the length or width of the right occipital condyle or the area of the foramen magnum might help improve the results (Uysal et al., 2005; Gapert et al., 2009a; Holland, 1986a).

This method needs to be tested on a larger population of European Americans and African Americans, and on peoples of another ancestry all together because it has been demonstrated many times in the past, sexual dimorphism is population specific (Keen, 1950; Angel, 1982). After this method is employed on a larger and more diverse sample of adults it should then be employed on juveniles for follow up and comparison to the Veroni et al. (2010) results.

Although my analysis on ancestral differences in the basicranium showed a distinct difference between the two populations, the overall results were under 80% and therefore I feel should only be used in conjunction with other methods or if it is the only method used its results should be taken for what they are which is far from certain. McKeown and Wescott (2010) incorporated the palate which has been noted for its ancestral differences (Isan and Steyn, 1999). It would appear that methods of (Holland, 1986b; McKeown and Wescott, 2010) are more accurate methods of distinguishing ancestry from the base of the cranium.

I must state one final message of caution. My results showed that this method is useful for determining sex and ancestry in European and African Americans from the Terry Collection and the Bass Donated Collection. As mentioned above and by Ousley and Jantz (1996), caution is called for when applying discriminant function approaches, to samples that were not well represented in the creation of said function. You also need to be careful when applying a discriminant function developed from a museum collection of African Americans to let us say a present day African American because secular changes observed in the crania may also reduce the accuracy (Wescott and Moore-Jansen, 2001).

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ID	Ancestry	Sex	B-O	FML-FMR	H-B	B-FML	B-FMR	O-FML	O-FMR	B-MastL	B-MastR	O-MastL	O-MastR
T-1022	Black	1	3.156738	3.401337	3.104734	3.071715	2.24793	2.308494	2.535627	5.021026	4.894509	5.260991	5.344488
T-1066R	White	1	3.632595	3.41134	2.55503	2.460526	2.463174	2.540177	2.545746	5.076026	5.021159	5.751759	5.95136
T-1079	White	1	3.426566	3.304025	2.725995	2.726485	2.575093	2.037221	2.248155	5.397754	5.396724	5.761853	5.849555
T-1103	White	2	3.399024	2.91473	2.802992	2.262423	2.12137	2.149507	2.427599	5.377439	5.106812	5.444364	5.288403
T-1105	Black	2	3.297089	2.900758	2.889975	2.193335	2.166517	2.210714	2.238659	5.156196	5.023115	5.176739	5.250124
T-1117	Black	1	3.950616	3.388203	2.997419	2.401379	2.389961	2.778219	2.912446	5.9199	5.880336	6.18276	6.550184
T-111R	White	1	3.749369	3.186744	3.083114	2.478641	2.461321	2.699405	2.373106	5.03072	5.107612	5.765006	5.511726
T-1120	White	2	3.272789	2.905074	2.636144	2.285072	2.356998	2.200616	1.990899	4.939382	4.760823	5.562453	5.315204
T-112R	White	2	3.747315	3.303885	2.819888	2.434563	2.519429	2.611459	2.466329	4.941066	5.190531	5.630925	5.519632
T-113R	White	1	4.174346	3.412936	3.198079	2.500436	2.433948	3.039074	2.931739	5.625818	5.506179	6.353261	6.252824
T-1153	White	2	3.329685	3.034677	2.735944	2.272239	2.330101	2.21333	2.215252	4.842364	4.996351	4.865788	5.02401
T-1163	Black	2	3.548855	2.999836	2.85941	2.342125	2.084487	2.394353	2.553035	5.430904	4.845639	5.483357	5.188369
T-1175	White	1	3.107295	2.909844	2.507172	2.166168	2.109384	2.036884	2.201677	5.25864	4.947649	5.293713	5.204185
T-1194	White	1	3.539494	3.281986	3.007336	2.376314	2.313212	2.474345	2.514571	5.016619	5.392294	5.708168	6.036828
T-11R	Black	2	3.53816	2.822455	3.001642	2.03388	2.153456	2.674606	2.238146	4.780175	4.601921	5.501689	5.102058
T-12	White	2	3.617467	3.262904	2.931875	2.682061	2.585865	2.285118	2.292617	5.28172	5.128733	5.686037	5.62105
T-1225	White	1	3.774299	3.092444	2.680383	2.663944	2.50612	2.461339	2.162389	5.680272	5.555886	5.961504	5.759266
T-1232	White	1	3.363741	3.079168	2.539007	2.16067	2.145702	2.433249	2.410606	5.825974	5.557645	5.872988	5.733446
T-1233R	White	2	3.550068	3.472385	2.914458	2.508898	2.587804	2.518392	2.440901	5.274288	5.264863	5.806938	5.587989
T-1239R	White	2	3.096384	2.896348	3.122776	2.32777	2.224487	1.908091	2.151186	5.095596	4.907661	5.272547	5.335348
T-1242	White	1	3.944501	3.63683	2.730134	2.849188	2.743759	2.355348	2.788626	5.686806	5.472787	6.090038	6.202302
T-1244	Black	1	3.707533	2.75393	3.209627	2.054048	2.119823	2.564477	2.572802	5.639905	5.594073	5.795426	5.592462
T-125	Black	1	3.488374	3.036288	3.343781	2.455876	2.440016	2.196265	2.214272	5.449613	4.899226	5.856898	5.954938
T-1288R	Black	2	3.383102	2.934919	2.895404	2.197989	2.243565	2.202603	2.375895	4.689142	4.901216	4.900258	5.492692
T-129	Black	1	3.639308	3.433132	3.386288	2.436014	2.478036	2.507185	2.594178	5.306975	5.337304	5.620612	5.941866
T-1291	Black	1	3.812313	3.177213	3.084406	2.82712	2.704077	2.083551	2.434531	6.004587	5.793062	6.183795	6.319944
T-130	Black	1	3.893415	3.066507	3.190596	2.246761	2.312244	2.67865	2.70808	5.060091	5.070023	5.27274	5.296731
T-132R	Black	2	3.543961	2.980236	2.815892	2.096714	2.217047	2.518683	2.482674	5.28186	5.366267	5.382076	5.271973
T-1348R	Black	2	3.30455	2.974442	2.709711	2.460054	2.271357	2.13631	2.125314	5.764282	4.932934	5.516162	4.840333
T-138	Black	1	3.578056	2.833759	3.117744	2.569918	2.61699	1.999682	2.059824	5.116334	5.4606	5.62512	5.916294
T-143	Black	1	3.335995	2.617509	2.899313	1.904012	1.86495	2.405375	2.370892	5.315224	5.413204	5.829142	5.623704
T-145R	Black	1	3.564161	3.153791	3.170569	2.371515	2.468315	2.44057	2.240882	6.122629	6.238116	6.556567	6.587029
T-146R	Black	2	3.160045	3.060068	3.320104	2.018172	2.086752	2.342553	2.390261	4.913677	5.297822	5.527511	5.675366

T-147	White	1	3.647401	3.338499	3.125489	2.326841	2.416611	2.632889	2.644582	5.227137	5.121096	6.270396	6.175499
T-14R	White	1	3.759865	3.688367	3.052774	2.578457	2.638026	2.68266	2.658262	5.802324	5.681508	6.192695	6.112125
T-151R	Black	2	3.542882	3.016218	2.761207	2.218238	2.208496	2.583389	2.47175	5.140616	5.150291	5.54689	5.314694
T-153R	Black	1	3.690461	3.068404	3.074672	2.114625	2.352958	2.693231	2.447934	4.966876	5.082108	5.024934	5.230333
T-1558	White	2	4.001948	3.19294	2.977605	2.463037	2.327025	2.690857	2.786955	5.246057	5.239556	5.896608	6.134876
T-155R	Black	1	3.125771	3.007416	3.193159	2.062601	2.209196	2.469062	2.051542	5.259412	5.48801	5.617703	5.53897
T-1562	White	2	3.784419	3.233381	2.767694	2.434496	2.360451	2.561515	2.655499	5.243777	5.126763	5.233686	5.484137
T-1563	White	2	3.258028	2.931806	2.903897	2.303836	2.274523	2.044164	2.154675	5.259225	5.121621	5.315063	5.243852
T-1566	White	2	3.794943	3.322587	3.058423	2.587175	2.683623	2.481363	2.360046	4.998164	5.066762	5.613851	5.6927
T-1567	White	2	3.392422	3.089194	2.643655	2.336829	2.216292	2.140008	2.519966	5.272159	5.100776	5.532484	5.621047
T-1574	White	2	3.701272	3.267937	3.008186	2.568129	2.46044	2.346964	2.517807	5.421456	5.417108	5.333172	5.689759
T-1582	White	2	3.867467	3.801678	2.82088	2.602071	2.850341	2.813744	2.6062	4.77911	5.277911	5.524907	5.750071
T-1589	Black	2	3.229688	2.449181	2.690704	2.084881	1.917981	1.983352	2.138081	5.270523	5.004074	5.147426	5.470682
T-158R	Black	2	3.28168	2.885973	3.068273	2.147945	2.292304	2.211234	2.171082	4.894791	4.800388	5.18454	5.040015
T-1590	Black	2	3.316054	2.972771	2.88053	2.218094	2.254534	2.410188	2.027393	5.093109	5.3068	5.424468	5.264162
T-1594	White	2	3.239878	3.297037	2.848138	2.499204	2.188689	2.297963	2.302897	4.978588	4.602156	5.442153	5.057894
T-1599	White	2	3.28631	3.340977	2.606159	2.432015	2.456405	2.297334	2.226167	5.209965	5.18381	5.55621	5.373381
T-1601	White	2	3.467263	3.06899	2.535542	2.347768	2.371169	2.229964	2.347712	5.055899	5.347712	5.455367	5.861517
T-1603	White	2	3.226597	3.686193	3.207177	2.49186	2.415325	2.349971	2.53885	5.169339	5.017076	5.508899	5.639211
T-1614	White	2	3.595867	3.347567	2.874365	2.39057	2.483787	2.514888	2.450271	5.069345	4.89797	5.672218	5.581597
T-1617	White	2	3.48056	3.194412	2.995519	2.26532	2.384346	2.478054	2.498633	4.861084	4.935299	5.447162	5.529376
T-1622	White	2	3.715199	3.217616	2.745155	2.54011	2.473708	2.392041	2.429531	5.436411	5.357532	5.751777	5.846737
T-1624	White	2	3.73667	3.119798	3.026089	2.452755	2.498162	2.437039	2.422065	4.965863	5.124587	5.930725	6.006023
T-1626	White	2	3.360205	2.751285	2.700007	2.16533	2.173928	2.212467	2.263376	4.999967	4.999405	5.680579	5.443303
T-177R	Black	2	2.969921	2.421072	3.015606	1.76777	1.867844	1.943846	2.113192	4.81691	5.305541	4.660827	5.24711
T-18R	Black	2	3.198931	2.667354	3.055053	2.240144	2.310661	1.903645	1.990576	5.052996	5.285764	5.249228	5.553797
T-198R	White	1	3.541812	3.180985	2.711681	2.451085	2.054495	2.472986	2.548865	5.692677	5.726702	6.103595	6.17287
T-19R	Black	2	3.386663	3.023566	3.067986	2.500222	2.303604	1.993409	2.306962	5.129516	5.050337	5.668877	5.707265
T-206R	White	2	3.601297	3.427661	2.845789	2.344199	2.459489	2.678981	2.493042	5.30248	5.175463	5.277646	5.460426
T-20R	White	2	3.903492	3.504268	2.694209	2.648371	2.616636	2.678808	2.662028	5.766895	5.894253	5.979161	6.044616
T-233	White	1	3.773785	3.384867	3.210646	2.384636	2.23883	2.837367	2.859902	5.506668	5.543247	6.247541	6.313221
T-235	Black	1	3.721309	3.273691	2.97745	2.348942	2.220664	2.736572	2.765348	6.233585	5.519276	6.171473	5.578467
T-23R	Black	2	3.288724	2.944262	2.917412	2.087157	2.074295	2.320975	2.359626	4.913353	4.87073	5.403688	4.984912
T-24R	Black	2	3.375719	2.551472	2.878788	2.108533	2.154971	2.310888	2.070464	5.228688	4.874401	5.487966	4.98792

T-253R	Black	2	3.492513	3.082785	2.856244	2.415812	2.461689	2.213153	2.355808	4.858256	4.817786	5.231004	5.421639
T-25R	Black	2	3.819613	2.829875	2.547062	2.252569	2.258972	2.624266	2.442534	4.695012	4.463629	5.303311	5.062558
T-263	White	1	3.30875	3.0538	2.593667	2.549933	2.303096	2.143388	2.072654	5.530064	5.645268	5.738413	5.759371
T-26R	Black	2	3.673275	2.80471	2.902515	2.284805	2.197604	2.333406	2.494187	5.004493	4.739628	5.277136	5.064338
T-27	White	2	3.705239	2.910599	3.351421	2.306807	2.320336	2.336612	2.510087	4.57664	4.539042	5.040702	5.38874
T-27R	Black	2	3.07075	3.078235	3.120173	2.190326	2.243752	2.390115	1.979019	5.119385	5.221349	5.117475	4.922502
T-239R	White	2	3.211242	2.9312	2.810027	2.358165	0.878456	1.861945	3.327486	5.700035	5.072676	5.768461	5.767133
T-294R	Black	2	4.030206	3.446841	3.599444	2.336046	2.39481	3.12058	2.891522	5.180151	5.153925	5.916609	5.789803
T-295R	White	2	3.4316	3.034897	3.247977	2.23101	2.28703	2.508866	2.135928	4.772834	5.025681	5.614962	5.493928
T-302R	Black	1	3.522155	2.9671	3.076897	2.297168	2.25026	2.418555	2.397823	5.44447	5.291258	5.603014	5.408343
T-303R	White	1	3.902113	3.39856	3.152353	2.570147	2.504485	2.7244	2.686059	5.607618	5.727363	5.999822	6.022877
T-306	White	2	3.623199	3.316463	2.706148	2.408526	2.564702	2.489527	2.485103	4.665728	5.147004	5.187259	5.748284
T-30R	Black	1	4.030221	3.429892	3.297953	2.344815	2.512494	2.955521	3.051718	5.576113	5.395337	6.147201	6.176097
T-311R	White	1	3.830773	3.478427	2.951282	2.477258	2.705733	2.515487	2.691265	5.384325	5.324738	5.960675	5.919882
T-31R	Black	1	4.048455	3.127954	3.322113	2.300549	2.244681	2.868326	2.893398	5.251885	5.328979	6.071688	5.994927
T-34R	White	1	3.403471	3.219549	2.694469	2.421565	2.517253	2.33557	2.109248	6.483055	5.69561	6.015165	5.557818
T-353	Black	1	3.562924	2.851878	3.303751	2.436758	2.40117	2.291996	2.138055	5.574877	5.589882	6.002133	5.933377
T-359R	White	2	3.814604	3.622671	3.051641	2.719368	2.812628	2.522074	2.510167	5.350385	5.224126	5.731399	5.852019
T-35R	Black	1	3.486751	2.697341	3.821483	2.129845	2.285581	2.246424	2.206354	5.619674	5.397556	5.953939	6.03075
T-360	Black	1	3.827919	3.001622	3.007249	2.371599	2.418382	2.513624	2.485347	5.481908	5.451769	5.76058	5.838466
T-361	White	1	3.800527	3.449249	2.913422	2.423675	2.51888	2.812231	2.542786	5.561663	5.831225	6.406362	6.343624
T-362	Black	1	3.868689	3.306639	3.73517	2.617254	2.568825	2.568212	2.541319	5.643986	5.687179	6.522022	6.393649
T-36R	Black	1	3.564833	2.940841	3.858281	2.438913	2.575411	2.179632	2.086484	5.882426	5.657595	6.43001	6.203354
T-377	Black	1	3.945172	3.217361	2.768862	2.392574	2.340393	2.825947	2.820301	5.489664	5.225731	5.641965	5.719132
T-381	Black	1	3.687716	3.262337	2.725534	2.399006	2.390145	2.766962	2.399549	5.595894	5.237234	6.205633	5.773991
T-382R	Black	1	4.043357	3.258873	3.16424	2.709023	2.443661	2.688987	2.684968	5.30304	5.577943	5.434143	6.057261
T-385	Black	1	3.768972	2.546627	2.873858	2.525022	2.533705	2.025061	2.045407	5.219066	5.407629	5.698243	5.913896
T-387R	White	2	3.278502	2.990738	3.052373	2.245053	2.3238	2.173862	2.145222	5.278699	5.222766	5.635304	5.311354
T-38R	Black	2	3.561796	2.939026	2.6756	2.373547	2.243854	2.333793	2.361463	5.525509	5.360498	5.852154	5.642059
T-39	Black	2	3.422052	2.845066	3.345774	2.077895	2.284243	2.392085	2.168033	4.847188	5.306895	5.834998	5.39616
T-394R	White	2	3.745714	3.668507	3.157419	2.603107	2.449512	2.704932	2.736809	5.441419	5.351381	5.7304	6.056948
T-397	White	1	3.882861	3.39271	2.615792	2.450301	2.508787	2.760122	2.610378	5.916403	5.743413	6.523927	6.569943
T-400	Black	1	4.192957	3.324708	2.896983	2.506578	2.633415	2.7535	2.856136	5.578278	5.345226	5.82194	5.767358
T-404	Black	1	4.014172	3.089936	3.670464	2.323281	2.164444	2.902874	2.808963	5.392606	4.932554	5.942324	5.467176

T-405R	White	2	3.150841	2.761968	2.795643	2.323647	2.283256	1.937939	1.949184	4.857861	4.890194	5.284452	5.108732
T-417	White	1	3.58996	3.024901	2.821019	2.598258	2.497904	2.245821	2.247346	5.594634	5.658076	5.895052	5.804388
T-41R	White	2	3.225452	3.162384	2.576851	2.238121	2.2971	2.399477	2.170646	5.061087	5.278757	5.247901	5.330797
T-420	White	1	3.61949	3.202642	3.558766	2.458584	2.263692	2.190606	2.743524	5.524723	5.655716	6.048013	6.368263
T-42R	Black	2	3.494028	3.128952	2.869803	2.20912	2.167018	2.437238	2.598272	4.992756	5.234808	5.675873	5.711971
T-431	White	1	3.775879	3.154462	3.500943	2.516573	2.522789	2.474878	2.364692	5.448381	5.689683	6.026531	6.202963
T-433	White	1	3.450003	3.203214	3.161594	2.509092	2.216635	2.31967	2.396541	5.278993	5.638983	5.836974	6.197338
T-434	White	1	3.442063	2.871957	3.003276	2.300526	2.254055	2.312658	2.204881	5.806315	5.550651	5.902788	5.705341
T-440	White	1	3.604398	3.344681	2.987846	2.590141	2.439722	2.546312	2.457216	5.858718	5.597053	5.899303	6.063752
T-441	Black	1	3.639269	2.913041	3.118292	2.515846	2.540833	2.136278	2.324582	5.024734	5.074447	4.598935	5.119359
T-444	Black	1	3.819539	3.389996	3.712389	2.478259	2.228919	2.60956	2.933021	6.094615	5.655512	6.516262	6.305568
T-46R	Black	2	3.259834	2.860818	3.014873	2.204913	2.073571	2.261025	2.160345	5.388758	5.52212	5.537765	5.526932
T-487	Black	2	3.178096	2.997371	3.178988	2.293471	2.389359	2.036845	2.1094	4.939097	4.964948	5.1584	5.027394
T-489R	White	1	3.871323	3.543929	2.702195	2.585441	2.32602	2.883376	2.749363	5.271532	5.14668	5.644047	6.065044
T-496	White	1	3.390853	3.07229	2.865831	2.362779	2.371028	2.16973	2.306999	5.197814	5.111345	5.310059	5.494584
T-506	White	1	3.68845	3.00322	3.021404	2.466462	2.487043	2.201063	2.408819	5.497258	5.869219	6.199465	6.665961
T-50R	Black	1	3.837481	3.405495	3.131563	2.516915	2.547394	2.798727	2.550994	5.861831	5.773768	6.223944	5.865663
T-513R	White	2	3.290145	3.050041	3.113813	2.386908	2.194622	2.279619	2.136	5.282663	5.24794	5.678224	5.425219
T-518	Black	1	3.890969	3.056801	3.3104	2.153896	2.417995	2.773919	2.557476	5.728518	5.874633	6.131995	6.300157
T-51R	Black	2	3.622283	3.037964	3.189656	2.221369	2.93326	2.656134	2.346045	5.166489	5.336997	5.84909	5.525476
T-520	Black	2	3.062584	2.838949	3.226207	2.333669	2.288342	1.971697	1.908344	5.841119	5.141115	5.556741	5.326279
T-530	Black	2	3.85339	2.725432	3.057644	2.323717	2.300625	2.489104	2.419769	5.085567	5.134843	5.954508	5.595252
T-541	Black	2	3.986902	2.806528	3.169236	2.202738	2.189134	2.76887	2.753392	4.899316	4.792071	5.833488	5.495704
T-542	White	1	3.839981	3.435645	2.530628	2.441322	2.52209	2.68312	2.695976	5.769175	5.658553	6.37531	6.260415
T-546	White	1	3.29519	2.621269	2.92995	2.108248	2.123812	2.137144	2.128987	5.322092	5.270645	5.683951	5.705543
T-57R	Black	2	3.994859	2.925031	2.697071	2.152389	2.274363	2.858037	2.717957	5.316404	5.048137	5.374717	5.197288
T-58RR	Black	1	3.347825	2.802097	3.07714	1.911304	2.188646	2.254163	2.478603	5.401807	5.263594	5.438322	5.4292
T-593	Black	1	3.727276	3.066003	3.086202	2.214845	2.139062	2.595848	2.798449	5.29677	5.509422	5.580348	6.055127
T-594	Black	1	3.741091	2.973206	2.980346	2.254162	2.242358	2.435947	2.646333	5.668496	5.732553	5.971119	6.312767
T-59R	White	1	3.792538	3.821502	2.754008	2.640288	2.686075	2.690051	2.778781	5.568705	5.598672	5.801122	5.625692
T-603	Black	2	3.084516	2.911006	2.994271	2.272641	2.162194	1.917621	2.148429	4.938892	5.001177	5.29699	5.545765
T-608	White	1	3.347223	3.21471	3.018239	2.465766	2.467414	2.117541	2.265025	5.576687	5.260049	5.635676	5.623681
T-60R	Black	2	3.673862	2.896785	3.240363	2.116471	2.024662	2.693451	2.634045	4.840011	5.072981	5.57562	5.582441
T-61	Black	1	3.724244	3.1012	3.270657	2.314885	2.443132	2.44812	2.525825	5.402178	4.739457	5.490791	5.139414

T-610	Black	2	3.526418	3.003909	3.129894	2.253924	2.201589	2.562341	2.286721	5.238416	5.000578	5.592161	4.959961
T-620	White	1	3.346788	3.123615	2.444465	2.57271	2.486782	2.191953	2.058269	5.763288	5.82339	5.747163	5.683765
T-62RR	White	1	3.797541	3.809355	3.132418	2.581628	2.513706	2.998229	2.733823	5.844322	5.78342	5.963911	6.288171
T-632	Black	2	4.192008	3.55159	3.251835	2.523004	2.642521	3.041014	2.920483	5.230628	5.623462	5.782348	5.97691
T-645	White	1	3.34471	3.399803	3.200186	2.43566	2.214089	2.796095	2.214938	5.463046	5.642188	5.562952	5.58033
T-646	Black	1	3.418174	2.854327	3.526977	2.434217	2.142341	1.878783	2.420557	5.398595	5.440997	5.563	5.889567
T-651	White	1	3.077246	2.951978	2.717451	2.224764	2.185496	1.934648	2.193138	5.698595	5.501132	5.700071	5.839081
T-671	White	1	3.175504	3.157274	3.018927	2.262773	2.305568	2.206822	2.184254	5.509538	5.214365	5.780443	5.491611
T-687	White	1	3.360608	2.933198	3.102451	2.500618	2.370823	2.093727	2.132769	5.168483	5.232814	5.669394	5.628555
T-68R	Black	2	3.593504	2.797584	2.994164	1.901172	1.944554	2.657431	2.686702	4.949863	5.229452	5.269804	5.474665
T-696	White	1	3.975939	3.567015	3.313541	2.570764	2.701266	2.639543	2.958796	5.079388	5.110533	6.108657	6.007507
T-697R	White	1	3.77983	3.377305	3.269466	2.599475	2.531977	2.444154	2.606425	5.630956	5.477469	6.2116	6.160965
T-70R	Black	1	3.592186	3.232915	3.316357	2.466726	2.46991	2.516555	2.221676	5.382242	5.301845	5.932356	5.657199
T-716R	Black	1	3.794478	2.810633	3.51837	2.499352	2.36449	2.203555	2.403915	5.074533	5.746584	5.222239	6.804206
T-717	Black	1	3.40468	2.999082	2.808223	2.30394	2.112435	2.28957	2.475654	4.814394	4.863357	5.403523	5.294451
T-74R	Black	2	3.00336	2.969234	3.101887	2.39933	2.302717	1.993334	1.850221	5.326452	4.894452	5.391189	5.05622
T-774R	Black	2	3.527983	3.216558	2.996571	2.338917	2.297837	2.417241	2.54968	5.377361	5.386557	5.666565	5.60562
T-7R	Black	1	3.452207	2.828991	2.712866	2.151481	2.169682	2.302054	2.315655	4.787503	5.108338	5.320354	5.514989
T-8	Black	1	3.732064	3.036842	2.801841	2.369566	2.293658	2.526144	2.456715	5.126644	5.24544	5.052515	5.586591
T-805	White	1	3.813584	3.234408	3.027618	2.607514	2.338804	2.628711	2.550371	5.567658	5.28776	6.006581	5.805941
T-887	Black	2	3.298897	2.844907	2.554016	2.297611	2.077323	2.108142	2.28469	5.260314	5.251844	5.274084	5.622278
T-88RR	Black	1	3.600841	3.395543	3.612132	2.73161	2.740355	2.26636	2.27319	5.885722	5.591981	5.770143	5.790566
T-89R	Black	1	4.036207	3.264643	3.281792	2.474346	2.339454	2.597076	3.083254	5.56855	5.511463	5.836485	6.10426
T-901R	White	1	3.561121	3.263506	2.774975	2.523019	2.328676	2.380112	2.50096	5.545523	5.51919	5.910699	6.039449
T-905	Black	1	3.872388	3.178134	2.863249	2.705095	2.454317	2.246916	2.65684	5.717051	5.755448	5.797347	6.436901
T-949	Black	2	3.563985	3.068059	3.333761	2.361846	2.273864	2.293903	2.651802	5.273362	5.192533	5.306278	5.718994
T-95R	Black	1	3.650444	2.974577	3.285447	2.369351	2.354698	2.241271	2.546313	5.435004	5.313893	5.648885	5.843503
T-990	Black	1	3.764816	3.365409	2.799994	2.386786	2.545988	2.573058	2.622242	5.650144	5.402289	5.805833	5.927084
T-9R	Black	1	3.736393	2.895557	3.079713	2.446576	2.420799	2.30061	2.307029	5.602867	5.68414	5.746472	6.001181
T-1593	White	2	3.644808	3.637627	2.852328	2.555211	2.516252	2.507572	2.719507	4.840158	4.96903	5.361691	5.449141
UT1-82	White	1	3.918038	3.687884	2.763088	2.771002	2.773319	2.817978	2.45054	5.562984	5.579278	5.970288	6.100642
UT10-88	White	1	3.978988	3.325389	3.448669	2.931076	2.764217	2.498636	2.329962	6.02861	5.587972	6.800049	6.272866
UT10-91	White	1	3.973139	3.300557	3.520821	2.396702	2.380876	2.791887	2.901705	5.328029	5.417501	5.744749	5.99289
UT10-95	White	1	3.770325	3.304763	3.449788	2.498831	2.46714	2.623307	2.575821	5.397463	5.619515	6.373376	6.038928

UT10-98	White	2	3.347099	2.831987	2.881093	2.42685	2.21792	2.11124	2.039754	5.558361	5.439187	5.83286	5.535147
UT10-99	Black	1	3.673499	3.249951	3.341679	2.525269	2.330985	2.618389	2.415192	5.5489	5.919067	6.374392	6.060968
UT11-97	White	1	3.646857	3.45586	3.40207	2.473913	2.604249	2.496932	2.473294	5.691458	5.724222	6.091119	5.716689
UT11-98	Black	1	3.708949	3.159355	3.275528	2.439365	2.464555	2.38854	2.466776	5.566447	5.398546	6.744048	6.281289
UT12-88	White	1	3.839333	3.275333	3.023132	2.672541	2.706811	2.336255	2.400533	5.428157	5.415433	6.149234	6.341631
UT13-88	White	1	3.689853	2.945651	3.451474	2.536462	2.382813	2.328309	2.277918	6.042992	5.627579	6.660971	6.298832
UT13-91	White	1	3.789447	3.438837	2.861031	2.371136	2.457544	2.70023	2.770304	5.416512	5.688742	5.973936	5.819362
UT14-93	White	1	3.720663	3.39685	2.880064	2.579192	2.445179	2.57452	2.531118	5.944972	5.788492	6.00114	5.892605
UT14-97	Black	1	3.331738	2.944279	3.162574	2.196515	2.113152	2.461344	2.165611	5.489004	5.338547	5.873186	5.806424
UT15-89	Black	1	3.777307	2.967925	2.803063	2.256737	2.357717	2.577769	2.463094	5.284266	5.367619	6.271203	5.981388
UT15-90	Black	1	3.607917	3.429224	2.969758	2.717989	2.602065	2.356693	2.396411	5.432379	5.250412	5.886056	5.236483
UT15-97	Black	2	3.332083	2.505588	2.99361	2.139311	1.959387	2.065167	2.217667	4.724796	5.069847	5.217121	5.274753
UT16-89	White	1	3.20054	3.109242	3.138524	2.207464	2.400535	2.304096	2.271596	5.25304	5.304897	5.841807	5.813755
UT16-91	White	1	3.25111	3.155893	3.019742	2.167657	2.490954	2.281974	2.15685	5.226976	5.591099	5.729644	5.654904
UT17-87	Black	1	3.825374	3.066099	3.370538	2.14184	2.280963	2.782216	2.772783	5.172432	5.037218	6.034516	5.597611
UT17-91	White	1	3.56591	3.444393	3.490055	2.32862	2.447492	2.701622	2.497042	5.4782	5.687255	6.087561	6.216883
UT1-81	White	1	3.657016	3.283361	2.804289	2.258398	2.324211	2.646808	2.618923	5.058158	5.506704	5.76021	5.983819
UT1-84	White	1	3.583715	3.638671	2.707565	2.414984	2.76757	2.721844	2.288669	5.164465	5.106932	5.823228	5.595013
UT1-87	White	1	3.749798	3.434486	3.195208	2.585259	2.743879	2.691952	2.246912	5.667661	5.889975	6.398812	6.093046
UT18-88	Black	1	3.56591	3.444393	3.490055	2.32862	2.447492	2.701622	2.497042	5.4782	5.687255	6.087561	6.216883
UT18-90	Black	1	3.583926	3.042394	3.138437	2.286234	2.475126	2.369295	2.306208	5.792107	5.646086	6.028266	6.16887
UT18-93	White	1	3.396521	3.506254	3.390154	2.46879	2.212383	2.524897	2.610265	6.004356	5.887983	6.275287	6.595169
UT1-92	Black	1	3.869409	2.988171	3.086922	2.255212	2.47779	2.503697	2.580004	5.331349	5.388181	6.040409	6.223466
UT1-95	White	1	4.113728	3.508492	3.209364	2.751665	2.815824	2.66182	2.644914	5.766102	6.110777	6.059269	6.031261
UT19-90	White	1	3.893342	3.34588	2.809607	2.864445	2.724518	2.599384	2.311285	5.492495	5.664886	5.985138	5.874449
UT19-92	White	1	3.573406	3.276375	2.951206	2.465889	2.43266	2.565392	2.236648	5.904721	5.838066	6.829938	6.243504
UT20-90	White	1	3.605336	2.931074	3.137099	2.272029	2.242047	2.448126	2.355947	5.125212	5.172958	5.544219	5.287177
UT21-92	Black	1	4.140482	3.599686	3.323677	2.669813	2.620224	2.897789	2.81542	5.992764	6.340064	6.365741	6.248022
UT22-91	White	1	3.779054	3.357361	3.352222	2.554877	2.64378	2.499889	2.509406	5.601698	5.613494	6.322958	6.192843
UT23-94	White	1	3.46487	3.299942	3.079003	2.037699	2.094064	2.79786	2.760145	5.621209	5.73001	5.710919	5.729625
UT25-93	Black	1	4.01942	3.030757	3.032632	2.423023	2.485226	2.652236	2.627725	5.40812	5.517206	6.210524	6.190732
UT27-91	White	2	3.366368	3.167226	2.853272	2.413923	2.42742	2.187075	2.344576	5.289819	5.177266	5.675118	5.789477
UT27-93	White	1	4.232304	3.838677	3.936333	2.775129	2.682806	3.116626	3.114215	5.673343	5.603508	6.820765	6.584458
UT2-86	Black	2	3.388443	2.911203	3.019987	2.209773	2.419906	2.206841	2.20648	5.473932	5.24648	5.956756	5.136659

UT2-89	White	1	3.867904	3.339921	3.441065	2.525471	2.537369	2.698478	2.483283	5.301787	5.933554	5.920322	6.021775
UT28-90	White	2	3.637903	3.090959	2.860697	2.357778	2.225134	2.508797	2.513355	5.203726	5.227356	5.614018	5.248216
UT2-92	White	2	3.454796	3.335304	3.065367	2.394581	2.444215	2.471798	2.292061	4.691438	4.730833	5.681459	5.26997
UT2-95	White	2	3.35821	2.647643	2.786002	2.127609	1.992278	2.19755	2.256101	5.09425	4.839049	5.339089	5.202495
UT2-96	White	1	3.371559	3.039859	3.182661	2.388705	2.434861	2.373223	2.132751	5.216493	5.042369	5.595256	4.871651
UT2-97	White	2	3.936198	3.295132	2.58152	2.45366	2.251314	2.776521	2.821016	5.353912	5.543752	5.658834	5.737145
UT29-93	White	1	3.739489	3.330291	2.909882	2.558942	2.759163	2.425958	2.319262	5.531301	5.447628	6.375059	6.042983
UT31-93	Black	1	3.986213	3.207047	3.023846	2.171855	2.386727	3.103557	2.629507	5.891278	5.66656	6.208321	6.023271
UT3-81	White	1	3.596102	3.370036	3.304618	2.644326	2.675761	2.560176	2.051519	5.781482	5.485903	6.376913	5.765196
UT3-83	White	1	3.22235	2.989382	3.250206	2.125985	2.223081	2.180728	2.281854	5.11436	5.359508	5.56316	5.537362
UT3-87	White	1	3.878386	3.295266	3.365924	2.549418	2.727972	2.521464	2.464631	5.712918	5.866479	5.787075	6.067197
UT3-89	Black	1	3.493082	3.162907	2.820136	2.164417	2.332236	2.444456	2.529206	5.202051	5.375007	5.533802	5.154087
UT38-93	White	1	3.535001	3.599577	3.109095	2.622488	2.368643	2.721457	2.477604	5.58875	5.817441	6.549879	6.313961
UT3-90	White	1	3.364575	3.425525	3.094714	2.494441	2.498032	2.26469	2.387187	5.814717	5.870961	6.123897	6.434864
UT42-93	Black	2	3.789476	3.428661	2.652154	2.362941	2.638955	2.669485	2.600736	5.504327	5.57988	5.665708	5.521823
UT44-93	White	1	3.566875	3.504735	2.941195	2.518413	2.561951	2.545144	2.397776	5.631539	5.402537	6.219643	5.869119
UT4-87	White	1	4.046809	3.309671	2.585587	2.641182	2.820331	2.608583	2.446962	5.035587	5.290822	6.010378	5.945368
UT4-88	Black	1	4.274113	3.149247	3.480062	2.487328	2.480967	2.915435	2.797311	5.048869	5.224141	5.947923	5.973922
UT4-95	Black	1	3.755196	2.972074	2.821192	2.367606	2.48355	2.325893	2.430675	5.329547	5.273392	5.84689	5.757573
UT4-97	White	1	4.385315	3.688204	3.601393	2.682826	2.653616	3.207066	2.996013	5.870264	5.504634	6.342566	5.989567
UT5-87	White	2	3.399386	2.950707	3.132117	2.190886	2.146104	3.393461	2.279279	4.659831	4.697474	5.610804	5.577971
UT5-88	White	1	3.723813	3.730158	2.829815	2.780133	2.541242	2.756339	2.513937	5.972859	5.947669	6.327667	6.341887
UT5-93	White	1	3.570265	3.103056	2.963072	3.351142	2.459293	2.483723	2.165308	5.919282	6.010145	6.270505	5.922243
UT5-94	Black	1	3.715746	3.315924	3.238973	2.613318	2.399393	2.396771	2.546541	5.600596	5.578677	5.931182	5.894696
UT5-97	White	2	3.068233	3.014946	2.918957	2.188662	2.149795	2.131927	2.138098	5.09208	5.467416	5.532561	5.263839
UT5-98	White	1	3.473181	3.280511	3.324934	2.60451	2.363781	2.36171	2.280609	5.32351	5.426846	6.336787	5.815947
UT6-87	Black	1	3.733591	2.725525	3.304396	2.043169	2.039326	2.522499	2.680594	5.250198	5.420698	5.606943	5.470141
UT6-88	White	2	3.733582	3.017214	3.336825	2.171136	2.292528	2.663043	2.524794	4.841587	4.94954	5.907046	5.431149
UT6-89	Black	2	3.739691	2.713669	2.851683	2.252595	2.273725	2.355748	2.438547	5.08454	4.788172	5.278713	5.034516
UT7-87	White	1	3.973657	3.39826	3.229951	2.434815	2.343885	2.853332	2.883247	5.746531	6.359331	6.065977	6.682247
UT7-89	White	1	3.642747	3.186994	3.107741	2.547629	2.516475	2.354204	2.342041	5.781983	5.87188	6.368152	6.289492
UT7-91	White	1	3.789347	2.910506	2.987979	2.733482	2.474055	2.009041	2.356312	5.582079	5.566094	5.618542	6.158286
UT7-92	White	2	3.449823	3.123488	2.974143	2.198605	2.067486	2.679969	2.40655	4.956311	4.877677	5.641704	5.204117
UT7-94	White	1	3.486871	3.801238	3.294053	2.512743	2.718699	2.574154	2.554964	5.608028	5.853369	6.001292	6.079211

UT7-96	White	2	3.6242	3.331078	2.795325	2.343275	2.255321	2.593689	2.681865	5.356641	5.189114	5.513536	5.340286
UT7-98	White	2	3.309186	3.238749	2.86304	2.474628	2.268924	2.416094	2.229355	5.661003	5.622377	5.839773	5.549871
UT8-87	White	1	3.624116	3.648008	3.579954	2.687241	2.776359	2.359344	2.491282	5.55601	5.270366	6.017	5.744971
UT88-7	Black	1	3.746112	2.650434	3.282378	2.091374	2.292717	2.48991	2.306618	4.978465	5.575992	5.787444	5.599906
UT8-89	White	1	3.999157	3.358521	3.227614	2.666321	2.374732	2.655308	2.775004	5.866572	5.595566	6.120976	6.504162
UT8-96	White	1	3.481941	3.189908	3.194614	2.262405	2.287327	2.424198	2.488896	5.603769	5.595566	6.245032	6.313215
UT8-97	White	1	3.516157	3.285449	3.123935	2.321473	2.302526	2.671368	2.38192	5.445732	5.480061	5.971129	5.690703
UT96-30	Black	1	3.603986	2.909491	2.802619	2.434516	2.558237	2.14926	2.158106	5.382487	5.544758	6.198375	5.977874
UT98-25	White	2	3.245363	3.327212	2.540123	2.351591	2.280219	2.468235	2.2022	5.102863	5.57338	6.10865	5.659076
UT98-29	White	1	3.770874	3.14278	2.691501	2.320632	2.525742	2.753785	2.244357	5.489301	5.46004	6.316059	5.587869
UT9-88	White	1	3.704	3.261127	3.59149	2.545467	2.540839	2.420171	2.367971	5.82138	5.400352	6.182933	5.906887
UT9-89	Black	1	3.976585	3.42125	2.989427	2.510432	2.62757	2.606355	2.843763	5.886179	5.89682	6.087892	6.047476
UT9-93	White	1	3.157111	3.258205	2.750365	2.323265	2.380742	2.216758	2.161882	5.377485	5.407091	5.602525	5.42883
UT99-3	White	2	3.795793	3.19505	3.223185	2.356317	2.385697	2.72772	2.500594	4.760727	5.517354	5.672076	5.713997
UT9-95	White	2	3.452041	3.123821	3.476428	2.355571	2.337037	2.435459	2.356413	5.31511	5.381603	6.072027	6.404839
UT8-91	Black	1	3.789093	3.2928	3.145385	2.41994	2.329187	2.553967	2.746109	5.546465	5.221371	5.90163	5.897291
UT17-88	Black	1	3.961451	3.188428	3.5327	2.291799	2.434041	2.827348	2.379016	5.279986	5.092717	6.037107	5.600103
UT19-94	Black	1	3.616695	3.307466	2.964778	2.611357	2.553633	2.296541	2.409378	5.842372	5.38502	5.908651	5.802627
FOR73-1	Black	2	3.700785	3.048058	3.500383	2.32869	2.228312	2.52798	2.689711	5.11432	5.15744	5.581813	5.486953
FOR74-5	Black	2	3.53956	3.059628	3.107676	2.359173	2.369996	2.371178	2.259841	5.297823	5.020382	5.323447	5.058865
T-1273	Black	1	2.733711	3.262558	3.169243	2.400851	2.273799	2.774744	2.715121	5.577613	5.166841	5.994352	5.368684
T-1280	Black	1	4.382524	3.419633	3.791216	2.478103	2.448134	3.125885	3.233363	5.502087	5.498777	6.528809	6.407399
T-1281	Black	1	4.019066	3.262975	3.529664	2.564287	2.548051	2.799422	2.495239	5.8212	6.066839	6.760724	6.5477
T-1284R	Black	1	3.844299	2.872501	3.313881	2.270249	2.313173	2.673712	2.38894	5.648042	5.571461	6.149986	5.626088
T-1285	Black	1	3.462636	2.929908	2.723889	2.332555	2.332515	2.171202	2.243123	4.952569	5.250742	5.050194	5.16346
T-1289R	Black	2	3.489657	2.900539	2.875804	2.3739	2.31891	2.19705	2.192618	4.973054	5.178089	5.410152	5.357927
T-1293	Black	1	4.145264	2.98933	3.04911	2.531208	2.503183	2.639824	2.701789	5.502753	5.712083	6.18032	6.201556
T-1297	Black	2	3.8398	3.110245	3.06184	2.487091	2.437655	2.533914	2.456792	5.343689	5.454686	5.479587	5.804024
T-1298	Black	2	3.163716	2.896785	3.417024	2.228618	2.256859	2.011739	2.1519	4.956887	5.171938	4.894738	5.346547
T-1300	Black	1	3.782665	2.983205	2.956298	2.393151	2.434934	2.434086	2.411033	5.528832	5.66114	5.786678	5.862825
T-1304R	White	1	3.761456	3.34958	3.026186	2.449749	2.499508	2.58336	2.575627	6.041343	5.933136	6.145017	6.114952
T-549	Black	1	3.926606	2.91842	3.126522	2.198598	2.237833	2.69689	2.67751	5.266268	5.521523	5.826272	5.719259
T-559	Black	2	3.65628	2.856283	2.976267	2.431266	2.334258	2.306963	2.253197	5.071125	4.957376	5.521456	5.311462
T-606	Black	1	3.408102	2.697838	2.941691	1.965368	2.213043	2.526124	2.127959	5.155509	5.450627	5.820162	5.518607

T-607R	White	1	3.822126	3.343771	3.247206	2.595197	2.550006	2.412668	2.633283	5.585732	5.54509	6.190025	6.257698
T-615	Black	2	2.903938	2.951314	3.108746	2.174453	1.948447	1.875781	2.289905	5.351787	5.029705	5.461308	5.407103
T-616R	Black	2	3.695955	2.930048	3.180323	2.564096	2.324472	2.218739	2.404552	5.134821	5.061384	5.637736	5.620162
T-618	Black	1	4.096602	2.894633	3.275539	2.328184	2.202296	2.73571	2.855547	5.917294	5.809894	6.15311	6.312003
T-619	Black	1	3.951295	3.100655	3.300655	2.217369	2.153023	2.905886	2.890284	5.323858	5.38766	5.723066	5.798397