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Research Article

The Development of Eye Shape Photofit Database of the Chinese and Malay population in Malaysia

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Abstract

The objective of this work was to study the eye shape of the Chinese and Malay in Malaysia in order to establish a photofit database for these two groups of people. A total of 188 subjects (94 males and 94 females) ranging from 18 to 25 years old were randomly chosen from the population of Universiti Kebangsaan Malaysia. The eye width and intercanthal distance of each subject were measured for eye shape classification. SPSS analysis suggested that there was significant differences in the types of inter eye distance ($p<0.05$) and inter eye distance measurement ($p<0.01$) amongst the Chinese and Malays. Gender difference was found to be highly significant across inter eye distance measurement ($p<0.05$) however the opposite was noted across the types of inter eye distance ($p>0.05$). There was also significant differences across ages for types of inter eye distance ($p<0.05$) whereas insignificant results were obtained across the inter eye measurement parameter ($p>0.05$). Two-way between group ANOVA indicated that there was no significant difference ($p>0.05$) between races and gender; between races and ages; and between gender and ages; for inter eye distance measurement. This study also highlighted that race and gender plays a significant role across the types of inter eye distance and inter eye distance measurement. Wide set eyes appeared to be dominant in comparison to close set eyes across both races and gender. As an outcome of this study, an eye shape photofit database representing the Chinese and Malay population in Malaysia was made possible and can be used for forensic identification purpose.

Introduction

In recent years, the use of eyewitness identification has played a crucial role in apprehending criminal sunder police investigation. With the absence of physical evidence, eyewitness identification and testimony has become a strongly favorable form of proof in the court of law [1]. During the investigation process involving eyewitness, the eyewitness testimony is required, with the aid of a forensic artist, to construct a facial composite of the perpetrator for facial or photographic identification. Facial identification is a process whereby matching is conducted between the composite constructed according to eyewitness description and facial photographs obtained from the criminal database. In the past, forensic artists with polished interviewing and drawing skills are assigned to do this [2]. However, in recent years, it has becoming a daunting task to identify individuals with both skills [3]. Therefore, the police force has started to seek help from mechanical system and computerized systems; the most commonly utilized system is referred to as the 'photofit'.

Photofit® is an Australian commercialized software kit that contains examples of 560 photographed facial features that are printed on thin cards. Every example can be superimposed onto a special frame to produce a likeness-composite [4]. The setback of this kit is that it only caters for the Caucasian population/database, without any features representing the Asian population [5]. As Caucasians and Asians have very different facial characteristics, the photofit does not provide an accurate example of Asian features and characteristics, particularly for the purpose of facial reconstruction in Malaysia. Therefore, it is necessary to establish an Asian database for photofit in order to produce higher quality facial composites of Malaysians. In this research, the types of eye shape are studied. There are several types of eye shape which includes wide set eyes, close set eyes, deep set eyes, prominent or protruding eyes, hooded eyes and Asian eyes.

Wide set eyes have the intercanthal distance (distance between the eyes) that is larger than the width of one eye [6]. In contrast, close set eyes are classified as those whereby the width of one eye is larger than the intercanthal distance [7]. Prominent or protruding set eyes are eyes that jut out far forward from the eye socket and tend to dominate the entire facial feature of the person [8]. The opposite is noted for deep set eyes where the eyes are pushed back into the eye socket and appears to be sunken inward [9]. If the eyelid overlap with the crease or eye socket of a person, the person is said to possess hooded eyes [10]. Asian eyes are referred to eye sets that do not have crease and with the absence of folds on the upper eyelid [11]. This type of eye shape is most commonly found among Asians. In Malaysia, the use of photofit was made known when it was applied in the case

of kidnap, sexual assault and murder of Nurin Jazlin in 2007 and, in the UK, it was used in the kidnapping of banker Peter Shaw's case in 2002 [12,13]. Previous studies have also proved that the quality of photofit composites do not deteriorate over time in comparison to the composite constructed using MAC-A-MUG PRO system [14,15] (Figure 1).

This research focused its study on eye shapes of two major Malaysian ethnic groups; Malay and Chinese. Apart from ethnic groups, this research also looked into gender and age parameters; eye shapes across both sexes and also the eye shapes from population ranging between 18 and 25 years old.

Material and Methods

A total of 188 subjects, 94 Malay and 94 Chinese were calculated and determined from PASS 2008 (platform as a service [16], sample size calculator. Subjects were randomly selected from occupants of Campus Kuala Lumpur of Universiti Kebangsaan Malaysia (UKM) ranging from 18-25 years old. The number of males and females involved in this study were 94 respectively which consisted of 47 Malay males, 47 Malay females, 47 Chinese males and 47 Chinese females. The ratio 1:1 of males (50.54%) and females (49.46%) was selected as they represented the current census conducted across the Malaysian population in 2010 [17]. Inclusion factors for the subjects included Malaysians of Chinese and Malay descent with a valid blue identity card called "Mykad" and was between the ages of 18 until 25 years old. Subjects were also required to be of good health with the absence of any genetic abnormally affecting the eye and have never undergone any eye plastic surgery that could affect the appearance of the original eye shape. During the collection of samples, subjects were required to take off any eye accessories such as spectacles and color lens. They were also required to remove any eye make-up. This was to ensure that such artificial accessories do not affect the original appearance of the eye.

Figure 1: General types of eye shapes (wide set eyes, close set eyes, prominent or protruding set eyes, deep set eyes, hooded eyes and Asian eyes.

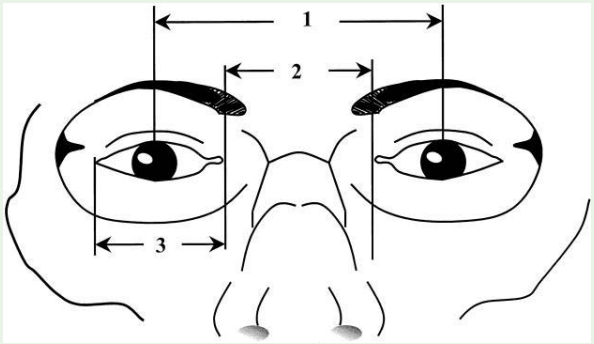

Figure 2: Pupillary distance (1), Intercanthal distance (2) and Eye width (3).

Once the subjects had fulfilled all the inclusion factors, they were then required to fill in a consent letter and a prepared questionnaire. After removal of all eye accessories, subjects were then required to sit upright on a chair with no humpback. A scale measurement ruler was held by the subject's dominant hand beside his/her own eyes to serve as calibrator. Subjects were then required to be relaxed, ensuring no facial expression that could alter the original eye shape. A photo of the entire face and one zooming into the pair of eyes with a scale measurement ruler situated perpendicular to the subject were taken using the Canon E0S Digital Single-Lens Reflex camera (Canon Inc, Japan) under bright conditions. The photos of the eyes were then studied and analyzed.

Eye spacing or intercanthal distance and width of both eyes were measured using software ImageJ (1.44o by Wayne Rasband National Institute of Health, USA) with a scale measurement ruler present in picture for calibration purposes. The measurements were taken in inches (inch) to two decimal places. Measurements were repeated twice and an average reading was taken. One observer was involved for the measurements as to prevent any inter-values errors. Similar instruments and protocols were applied throughout to maximize consistency of the measurements. The measurements were then used to classify the subject's eye; wide set eyes, close set eyes, deep set eyes, prominent or protruding eyes, hooded eyes and Asian eyes. Pupillary distance (1), Intercanthal distance (2) and eye width (3) are illustrated in figure 2.

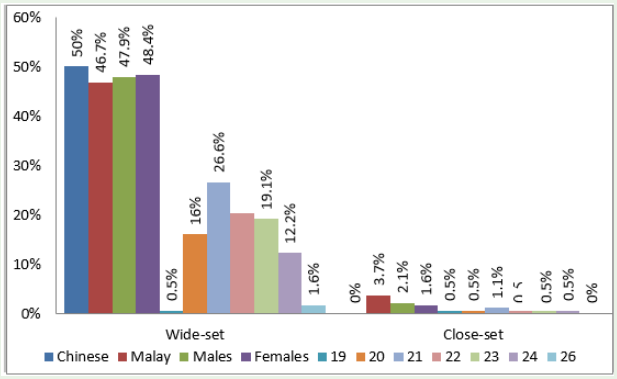

Figure 3: Percentage of races, sexes and age groups against the different types of inter eye distance.

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Table 1: Statistical results of types of inter eye distance and inter eye distance measurement.

	Types of inter eye distance	Inter eye distance measurement
Races (Chinese, Malay)	X^2 (1, N=188) =7.271, $p<0.05$	t (186) =8.852, $p<0.05$
Sexes (Males, Females)	X^2 (1, N=188) = 0.148, $p>0.05$	t (164.578) = -3.463, $p<0.05$
Age (19 - 26)	X^2 (6, N=186) =15.303, $p<0.05$	F (6,179) = 0.912, $p>0.05$

Table 2: Two-way between group ANOVA.

Factors	Statistical result
Races and Sexes	F (1,184) = 0.499, p>0.05
Races and Age	F (6,172) =1.885, p>0.05
Sexes and Age	F (4,174) = 0.995, p>0.05

All measurements were recorded in the form of numerical data and displayed in the form of a table. Percentage of each eye shape were calculated and illustrated in the form of a graph. Results were then recorded as nominal data and transferred into SPSS 12.0 [18] for statistical analysis. Bootstrapping was conducted to model differences between groups (especially among age groups due to limited sample sizes). Results are displayed with and without bootstrapping results. Normality distribution of the data was tested before parametric tests were conducted. Chi square test of independence ($p<0.05$) was then used to test the types of inter eye distance among races, sexes and age. Independent t-test was used to evaluate the inter eye distance measurement among races and sexes. While one-way between group ANOVA was used to evaluate the inter eye distance measurement across the ages, two-way between group ANOVA was applied to determine the inter eye distance measurement between races and sexes, races and age, and sexes and age.

Results

Only two types of inter eye distance were found in the target population. These were wide set eyes and close set eyes. Demography of the sample population based on the two types of inter eye distance are displayed in figure 3.

Statistical results showed that there were significant differences between the two types of inter eye distance based on race and age, but not for sexes. Further statistical analysis included two-way between group ANOVA. This was to study the effect of interaction between race, sex and age for inter eye distance measurement. Results indicated that there was no interaction between the above mentioned factors as depicted in table 1.

Two-way between group ANOVA carried out to test the interaction between race, sex and age for inter eye distance measurement showed that there was no significant difference among the factors (Table 2).

Discussion

Analysis indicated that there was significant difference across the types of inter eye distance and inters eye distance measurement between the Chinese and Malays. This finding is in line with [19] that suggested the chromosome 11 to be responsible for determining the final outcome of inter eye distance. In Malaysia, culturally, a Chinese with a darker skin tone is most often mistaken to be of Malay origin. However, through genetic analysis, a Chinese can be differentiated quite easily from Malay regardless of skin color. There are genes that control skin pigmentation and influence phenotype. This is reaffirmed through this study as there was significant difference noted in types of inter eye distance and inter eye distance measurement between Chinese and Malays.

In contrast, across sexes, this study showed no significant result for types of inter eye distance between males and females. Therefore, there was no association of gender for the types of inter eye distance. Since the genes that are associated with skin pigmentation in homosapiens are located on chromosomes 1, 2, 3, 5, 6, 7, 9, 13, 14, 15, 16, 17, 20, 22; and the 23rd pair is the sex chromosome, this could likely indicate that the genes controlling the types of inter eye distance is not present in the sex chromosome. It is likely present in the autosome or even in the Mitochondrial DNA (mtDNA). The absence of association of types of inter eye distance between sexes is supported by previous studies that looked into the various loci on the sex chromosome X and Y. For example, [21] had only found hemophilia, high blood pressure, congenital night blindness, Glucose-6-Phosphate-Dehydrogenase (G6PD) deficiency and color blindness loci in chromosome X, whereas, the Y chromosome contains the loci of the Sex Determining Region Y (SRY) gene [21].

However, the difference between sexes were clearly seen in the inter eye distance measurement. The difference noted here could be due to genetic variations. There are about 3 billion nucleotides in a human body and every individual differs by an average of 2 to 3 million base pairs. Such huge differences in the genetic pool most certainly cause some form of variations among human beings [22,23] supported this finding as in her study, 88%-90% of genetic variation between each individual and 10%-12% of variation among different populations were identified. This suggests that the differences in inter eye distance measurement among sexes were valid and justified.

There was no significant difference in inter eye distance measurement between age and sex and also between age and race. Observed power in races and sexes showed that both factors had their own ability to detect differences while age did not [24]. This was because the sample size of race and sex were sufficed to detect the differences independently but not enough to illustrate the interaction between both factors. Furthermore, small sample size across certain age groups could have caused the result to be not significant [25]. Sample size for future research for each age group should be at least 55 samples per group in order to display any form of association. We did conduct boot strapping to overcome our limited sample size caused by grouping by year of age.

This study highlighted the types of inter eye distance and inter eye distance measurement across two races (Chinese and Malay), sexes (male and female) and age range (19 to 26). It was obvious that a certain race could potentially have different types and measurement of inter eye distance. As for sex, there was no difference in types of inter eye distance between male and female, but they do differ in measurement even within the same type of inter eye distance. These measurements could potentially be a useful tool in the face mapping process during facial reconstruction. The data collected from this study can be used as a preliminary database for further research in the field.

Conclusion

Based on the results, both race and sex affected the types and measurement of inter eye distance. The findings also noted that wide set eyes was the dominant type of inter eye distance across both sex and race. With the increase of sample size for age, the sample size for race and sex has to be increased automatically. This new sample size could potentially illustrate new interactions between factors for inter eye distance measurement.

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