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Facial Anatomy and Mapping Across Races

[1]C. Stavrianos, [3]C. Papadopoulos, [1]O. Pantelidou, [2]J. Emmanouil and [4]N. Petalotis
[1]Department of Endodology (Forensic Odontology), [2]Department of Removable Prosthodontics, School of Dentistry, Aristotle University, Thessaloniki, Greece
[3]Department of Forensic Sciences (Forensic Odontology), University of Glamorgan, Wales, UK
[4]Health Center of Rodopolis, Greece

Abstract: The human face holds key information about identity such as age, sex and ethnicity, information that enables the identification of a single individual. The photographs are used commonly in identifications procedures so that lay people can make cursory identification by comparing the suspect in question with his/her photograph. The other race effect appears to have a significant influence in the face recognition process and facia mapping analyses.

Key words: Ethnicity, identification, people, photographs, suspect

INTRODUCTION

Facial images are one of the most valuable pieces of evidence for identification and it is possible in a very high proportion of cases wherein subjects recorded in photographs or on videotapes need to be identified by means of comparison with images of persons of known identity. The advantages and simplicity of visual identification by means of a photograph and the current interface of imagery with electronic equipment have led to the utilisation of ID photographs on many credential documents. However, the comparison of facial imagesis often a difficult task as there may be circumstances that may prevent or render facial recognition. The present study discusses the differences of facial anatomy among different racial groups and the possible impact upon the facial mapping techniques (Fraser *et al*., 2003; Ventura *et al*., 2004; Stavrianos, 2009; Davis *et al*., 2010).

FACIAL ANATOMY

The human face is a reflection of the individual uniqueness of a person. Facial appearance provides universally interpretable information about a person's gender, ethnicity, age, intelligence, their emotional state and their health. Biologically, the facial phenotype is a product of genetics and environment that reflects features of populations in specific regions (Iscan and Loth, 2000; Smeets *et al*., 2010).

The human face is a dynamic structure and can transmit a wide range of expressions and even the most subtle changes in expression may create a different perception in others. Emotions such as happiness, curiosity, concern, anger, fear, worry or surprise are instantly recorded and can just as quickly disappear. Physical and more permanent alterations result from aging, disease, weight gain/loss, graying and loss of hair or beard and exposure to the sun. Studies have reported that smoking can accelerate wrinkling (Iscan and Loth, 2000).

The human face comprises underlying skeleton, the skull to which the hard and soft tissues of the face are attached. The 3D shape of a particular face results from the combination of the underlying skeletal structure, the hard tissues, the soft fatty tissues and the skin. The skull creates the architectural form of the head and provides the basic structure for the face. Differences in these tissues plus variations in coloration and texture of the skin, eyes and hair provide the basic information which is used to categorize the face. Because all faces must be identical in basic design, sensitivity to rather subtle differences often needed to identify individuals from their faces. Anatomists have classified people into three major groups according to head or skull shape. The cephalic index, the term for measurement of the head is used to determine these head types: brachycephalic refers to relatively broad heads. Mesocephalic refers to medium heads. Dolichocephalic refers to relatively long heads (Bruce and Young, 1998; Taylor, 2000).

The skull creates the architectural form of the head and provides the basic structure for the face. A skull generally is viewed as representing two regions: the

Corresponding Author: C. Stavrianos, Department of Endodology (Forensic Odontology), School of Dentistry, Aristotle University, Thessaloniki, Greece

neurocranium or braincase and the splanchnocranium or face. Both regions are comprised of multiple bones joined together much like a jigsaw puzzle by interlocking sutures or seams. The face is supplied by various branches of the internal and external carotid system. All facial skin from the chin to the scalp vertex is innervated by three branches of the trigeminal nerve (Cranial nerve V). The ophthalmic division supplies the skin over the forehead, glabella and upper dorsum of the nose. The maxillary division supplies the skin of the midface. The mandibular division of Cranial nerve V supplies the skin of the lower lip, chin, lower mandibular region, lower gingiva and around the ear and temporal region (Taylor, 2000; Bentsianov and Blitzer, 2004).

While the hard and soft tissues of the face produce the individual variations in appearance which are important for categorization and identification, it is the movements of the face which are responsible for its ability to transmit a range of other social signals. Expressive movements provide information about emotional states, eye and head movements provide information about direction of attention and movement of lips, tongue and jaws provide information which aids speech perception. All these kind of movements are controlled by a bewildering variety of muscles (Bruce and Young, 1998).

The faces are interesting to observe because they have movement which is made possible by muscles and their ability to contract. The different functions of the human face require muscular movements. Facial muscles are divided into two general categories: muscles of mastication and muscles of expression although, they sometimes perform both functions. The facial muscles have evolved to include functions relating to sphincters for eye protection and oral competence. They also, assist in articulation for speech and bolus preparation in the oral cavity. Finally, they must convey the complex emotions and expressions to the world around us. These muscles of facial expression are all embryologic derivatives of the second pharyngeal arch and as such are all innervated by the nerve of the second arch (Cranial nerve VII) known as the facial nerve (Bruce and Young, 1998; Taylor, 2000; Bentsianov and Blitzer, 2004).

RACIAL DIFFERENCES IN FACIAL ANATOMY

Most definitions state that a race is a population that can be distinguished as a more or less distinct group by genetically transmitted physical characteristics. Anthropology attempts to describe human remains in the same terms as living people are described by society that is in this case by the major racial terms of white, black, East Asian and Native American.

The major racial groups (white, black and East Asian) exhibit some general differences in facial features. The white group is also been referred as the Caucasoids people. In profile, many Caucasoid skulls exhibit a somewhat flat face with zygomatic bones that retreat or slant back. Frontally, the nasal openings tend to be longer and narrower than in other races. The black group is also, referred as the Negroid. In reality, their skin colour actually varies on a continuum from light to rather dark brown. In profile, the Negroid skull often exhibits alveolar prognathism which is expressed as a projection of the lower face. Frontally, the nasal openings tend to be wider and shorter than in Caucasoids and Mongoloids with a bridge that is broader and flatter. Negroid mouths tend to be broader with fuller lips. Mongoloid people have been variously described as red or yellow and now a days are referred as the East Asian ethnic group. In truth, the Mongoloid category includes also Native Americans, American Eskimos and the various Asian groups with many varying skin colours and features.

The East Asian peoples and the Native Americans for instance have been separated on two distinct continents for at least 11,000 years and yet share many physical traits in common due to their common ancestry. Therefore, some anthropologists classify them together as mongoloid peoples and others split them into two separate geographic races (East Asian and Native American) based on the traits that do differ between them. In profile, the Mongoloid skull indicates an often flattened face with a short cranial vault or distance from front to back. Frontally, the cheek area is usually quite wide with projecting zygomatic bones. The width of the nose opening or nasal aperture is usually somewhere between the Caucasoid and the Negroid. Mongoloid mouths may also be of a size somewhere between the Caucasoid and the Negroid. In Table 1 there is a list of some of the common skeletal traits of the skull and face that are useful to forensic anthropologists because they vary significantly according to each race (Taylor, 2000; Pickering and Bachman, 2009).

Minor differences in genetics between people from different racial groups result in faces with different characteristic appearances. Skin and hair pigmentation provide the most obvious differences. The faces of different races differ in average shape as well as color (Bruce and Young, 1998).

Table 1: Presentation of some of the common skeletal traits of the skull and face that they vary significantly between different racial group

Traits	Native American	White	Black	East Asian
Skul shape	Short and medium	Long and medium	Long and narrow	Short and broad
Skul height	Low	High	Low	High
Nose form	Medium	Narrow	Broad	Medium
Nasal bones	Medium	Large and high	Medium and low	Small and flat
Nose projection	Low	High and prominent	Low	Very low
Lower nasal margin	Medium	Sharp and long spine	Dull and reduced spine	Medium
Nasal profile	Concavo-convex	Straight	Concave/Straight	Concave
Face breadth	Wide	Narrow/Medium	Medium	Very wide
Cheek bones	Prominent and angled suture	Reduced and curved suture	Reduced and angled suture	Prominent and angled suture
Mouth projection	Moderate	Reduced	Extreme	Moderate
Palate shape	Elliptic/Parabolic	Parabolic	Hyperbolic/Parabolic	Parabolic/Elliptic
Incisor form	Shovel shaped	Blade	Blade	Shovel shaped
Orbital form	Rhomboid	Rhomboid	Round	Round
Lower jaw	Robust	Medium	Thin	Robust
Chin	Blunt	Prominent	Reduced	Blunt

Modified from G.W. Gill in Forensic Osteology, 2nd ed., K.J. Reichs. Springfield, IL: Charles C. Thomas in 1998, 300

DISCUSSION

Considering the increasing number of crimes committed by persons of various ethnic groups in the borderless world, the accuracy and reliability of this identification system for other ethnic groups should be validated. In the research by Fraser *et al.* (2003), it was observed that it was more difficult for Caucasoid investigators to correctly approximate the orientation and size of the Japanese faces. Generally, most people report finding it difficult to recognize the faces of people of other races and probably tend to assume that this is because other race faces are more similar to each other than their own race (Bruce and Young, 1998).

However, most experiments have shown that each different race experiences a similar difficulty with faces form other races. The decrement in recognition of other race faces compared with own race appear to be similar for all racial groups. There is evidence that repeated exposure to faces of a single race has consequences for the perception of other race faces. This suggests that people of one race have learned to pay attention to rather subtle characteristics which distinguish different individuals within their own racial group but have not learned as well the dimensions which are more relevant to other racial groups (Bruce and Young, 1998). It was therefore, postulated that ethnicity bias might be due to real differences in facial morphology rather than difficulties inherent in superimposition of faces for people outside the investigators' own ethnic group.

Lan (1995) used data from different Chinese nationalities and has put forward the national difference in skull-image superimposition and clarified that the national difference is particular to this method, different from that in other fields. The identification standard is only applicable to its own nationality and the nationalities proving by observation and measurements, to be similar to it in features.

In legal and high security situations it is essential the requirement for exact identification of an individual. Positive recognition of an individual relies on facial characteristics that make a person distinctively different from all others which is different to classifying an individual into a population based on shared facial characteristics. Although, the comparison of facial components is important for identification, objective and reliable comparison methods leading to certain identification are currently lacking. In future, the process should be automated as far as possible to remove operator bias due to an ethnic effect (Glassman, 2000).

CONCLUSION

Further research is required to establish methods of facial mapping that will overcome the potential bias and eliminate the other race affect. It is important for future studies to consider the parameter of ethnic origin affect in face recognition and include in their a sample of participants from different ethnic backgrounds. This would be useful bearing in mind the circumstances that a forensic expert would come across in real-world.

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