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The unfamiliar face effect on forensic craniofacial reconstruction and recognition

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ABSTRACT

Previous research into the reliability of forensic craniofacial reconstruction (CFR) has focused primarily on the accuracy of reconstructed faces from European or African ancestry skulls. Moreover, the recognition of CFR in relation to the experience and ancestry of the practitioners and the assessors has not been previously considered. The cross-race effect is a recognised phenomenon in psychology studies, where familiar ancestry faces are recognised more readily than unfamiliar ancestry faces, but there is a paucity of research addressing the relationship between the accuracy of reconstructed faces and the familiarity with this ancestry by the practitioners/assessors. The aims of this research were to investigate whether 'unfamiliar-race effect' has any influence on the accuracy of CFR and to evaluate how much the correct recognition rate of CFR is affected by the cross-race effect. Eight CFRs from three ancestry groups were produced by experienced practitioners in order to explore the aims. The results demonstrated that practitioners produced more recognisable CFRs using skulls from a familiar ancestry than skulls from unfamiliar ancestries.

1. Introduction

Forensic craniofacial reconstruction (hereafter referred to as CFR) is a technique based on both scientific standards and artistic skill to rebuild a face onto a skull to recreate the ante-mortem appearance of the individual [1]. It is also known as forensic facial approximation or depiction [2,3]. The ultimate aim of CFR is to recreate an *in vivo* countenance (ante-mortem appearance) of an individual that sufficiently resembles the decedent in order to allow recognition and then identification of the individual [4]. CFR might be employed in forensic investigations where other means are not successful or available to identify human remains. It has also been used in archaeology to recreate the faces of paleontological and archaeological humans [5–7].

The accuracy of CFR has been of primary importance since the practice first emerged scientifically. Research has been directed toward producing not only more reliable reconstructed faces, but in establishing better means of estimating their accuracy. There are a number of influential factors on the accuracy of CFR: the CFR standards utilised, the practitioners, the assessors (recognisers) and mechanism of facial perception [8]. There is on-going research relating to refining and developing standards and guidelines for practice to increase the accuracy of these techniques and to provide a stronger base for public faith in the reproducibility of facial reconstruction to present reliable facial features of the targets [9]. CFR practitioners can also contribute the accuracy in relation to familiarity with the biological profile of the subjects and the degree of expertise, experience or training. In addition the assessors may also contribute to the efficacy in relation to familiarity with the target and experience and skills in facial recognition. The experience and skills of the assessor may be related to their own biological profile, such as sex, age and ancestry [8].

The prediction guidelines for rebuilding facial components include anthropometrical or morphological analysis of the skull and many are currently employed to predict the facial components: eyes [10–14], nose [15–19], mouth [20–24] and ears [15,20,25,26]. In addition, numerous sets of facial soft tissue depth measurements have been recorded from living subjects using a variety of clinical imaging techniques including; lateral cephalometric radiographs [27,28], computed tomography (CT)

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[29–32], magnetic resonance imaging (MRI) [33–35] and ultrasound [36–40]. Through these techniques, a large amount of facial tissue depth data has been collected from various geographical and ethnic group populations relating to sex, age and body mass index (BMI) for use in CFR. With advances in three-dimensional (3D) medical diagnosis technology, new equipment has been modified for the purpose of collecting more accurate tissue depth data. Of those, recently-developed cone-beam CT (CBCT) scanner has been introduced to the study of tissue depth measurements [41–43].

Since CFR was introduced as an identification tool in forensic science, there has been a great deal of research into the reliability and accuracy of the techniques. In an early publication, Wilder [44] stated that given the appropriate procedure and tables of facial tissue measurements it would be difficult not to produce a successful facial reconstruction. However, there have been a few studies that disagree with Wilder's theory. The first recorded accuracy study by Von Eggeling [45] using death masks reported no resemblance between reconstructed and target faces. Further research by Stadtmüller [46], using two faces reconstructed from the skulls of an elderly and a young man and facial soft tissue depth data from cadavers [47] and postmortem images for comparison, reported no similarity. Suk [48] insisted that the most common method of measuring facial soft tissue measurements was inaccurate, and concluded that a facial reconstruction from the skull must resort to fantasy. Most recently Stephan and Henneberg [49] investigated the accuracy and reliability of CFR using sixteen reconstructed faces and thirty seven assessors. They argued that 'facial approximation' should be considered highly inaccurate and unreliable as 403 incorrect identifications were made out of 592 identification scenarios.

However, there have been some contrasting studies that add weight to Wilder's theory. Gerasimov [50] asserted that all his CFRs produced from the skulls of cadavers were recognised with strong similarity when compared to the photographs from the deceased. He also reported that all of the 140 CFRs attempted in his laboratory were successfully identified. Snow et al. [51] carried out an accuracy study using ante-mortem photographs. They produced two male and female CFRs from the skulls of body donors, and participants were asked to match the reconstructed face to the target from a face pool. The results showed 26% correct identification for the female and 67% for the male. Gatliff and Snow [52] claimed 70% and 65% success rates for identification in two studies using reconstructed faces produced from their CFR technique. Vanezis et al. [53] attempted a comparison between the manual and computer generated facial reconstruction methods, and showed that both methods could be employed as a useful tool for identification. Wilkinson and Whittaker [54] reported more optimistic results on the accuracy of facial reconstruction. They produced 3D manual facial reconstructions from five juvenile female skulls, and then compared to a face pool by 50 volunteers. The results showed that the mean hit rate was 44% and all hit rates were above chance (10%). Subsequently, Wilkinson et al. [1] tested the accuracy of CFRs from two CT scanned skulls of a male and female generated by a computer modelling system. The results in face pool comparison tests demonstrated that the combined hit rate was 50% above the level recorded by chance (20%). More recently, Fernandes et al. [55] reported a unique accuracy study using three Brazilian CFRs from a skull employing three different tissue depth datasets. In the study, the volunteers who were familiar to the target face tested the accuracy of the CFRs in three different recognition tests. The results demonstrated a 27% hit rate for the CFR using the average tissue depth data from Brazilian live subjects, 23% for the CFR using the date from Brazilian cadaver study and 20% from the use of Rhine and Moore [56] date which was derived from American White population, and they concluded that the CFR method might be a useful to investigate forensic cases.

Although skepticism remains, a considerable number of researchers have proved that CFR can provide a reasonable resemblance to a face for which an identity is sought. Also a number of forensic cases have shown that the technique of CFR can be used to assist in the identification of individuals from unknown skulls, particularly when other forensic tools are unavailable [4,51,52,57–62].

Among the possible contributing factors to the accuracy of CFR, the ancestry of practitioners or assessors appears to be overlooked in the field of CFR study. The influence of ancestry on recognising human faces has been rigorously established by relevant cognitive psychology research. Since the early 20th century, cognitive psychologists have recognised a phenomenon where people show a tendency to recognise and memorise more accurately the faces of their own ancestry group than the faces from a different ancestry. This fascinating subject has been empirically established as a robust theory named 'cross-race effect (CRE)' (also referred to as the 'own-race effect/bias' or 'other-race effect') by the research related to eyewitness identification and facial recognition over the last four decades (for reviews, see Refs. [63–65]). In early years, the CRE had been empirically studied employing the faces from Black and White subjects. More recent studies have included different ancestry or national groups, such as British, German, Chinese, Japanese, Korean and South Asian, and demonstrated the CRE in face identification or recognition performance associated with investigating the mechanism of CRE [66–70]. For an instance, Tanaka et al. [66] investigated the differences in recognising same-race and other-race faces between Caucasian (White European) and Asian participants, and confirmed that Caucasian participants recognised same-race faces more holistically than Asian faces, while Asian participants demonstrated a holistic pattern when recognising both same (familiar)-race and other (unfamiliar)-race faces. From the results, they suggested that the same-race effect may arise from the holistic recognition of faces from highly familiar ancestry faces.

From early studies to recent research, the CRE has been found universally across various ancestry and ethnic groups with strong consistency. It is assumed that many theoretical mechanisms are involved in the CRE. This has been established by the studies showing the primary factors influencing the phenomenon: contact and attitudes with other-racial groups, encoding and representational processes, perceptual-memory expertise, and perceptual categorisation (for reviews, see Refs. [69,70]). According to the research into the theoretical underpinnings of the CRE, the differences in experience with the same (familiar)- and other (unfamiliar)-race faces (also known as the 'contact hypothesis') are considered the main contribution to the CRE [65,71–74].

In face processing, a recent study by Blais et al. [75] discovered a unique phenomenon between Western Caucasian and East Asian. They employed Western Caucasian young adults and East Asian participants who just arrived in the UK from East Asia to investigate possible differences in their eye tracking movements when viewing the target faces. In contrast to adults from Western cultures, the results revealed that individuals from Eastern cultures fixate centrally on the nose region and generally avoid eyes when learning, recognising, and categorising faces. These results demonstrated that face processing can no longer be considered as arising from a universal series of perceptual events that was presumed as a triangular pattern, but employed to extract visual information from the faces differs across cultural bases. As a new paradigm that people from different cultural background achieve human face processing by focusing on different facial information has emerged, it is essential to question what aspect of culture is contributing to the process. The most plausible explanation has been provided by Nisbett et al. [76,77] that Westerners tend to engage analytic perceptual strategies for processing face