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Are there ethnic differences of facial movements between Europeans and Asians?☆

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Summary *Purpose*. Due to the widespread use of Free Functional Muscle Transplant (FFMT) around the world to reanimate the paralysed face, it is important to be aware of ethnic differences in facial movements.

Methods and material. Participants in this study were born in Taiwan ($n=24$) and Austria ($n=24$). Analyses were conducted applying the digitised three-dimensional video-analysis system. All 48 subjects have never undergone any treatments in the face nor did they have previous histories of craniofacial anomalies.

Results. In general, Europeans were observed to have larger facial movements than Asians, from 0.4 mm (e.g. 5.7%) up to 3.9 mm (e.g. 30.3%), on average 1.3 mm $\pm$ 0.82 SD (e.g. 20.6%). Particularly the eyebrow, nose and mouth regions show statistically significant larger excursions on average 1.4 mm (e.g. 19.9%), 1.3 mm (e.g. 34.6%) and 3.0 mm (e.g. 30.3%). One exception is in the eye region, where Asians have a larger excursion (1.4 mm, e.g. 15.8%) of the eyelids, due to the larger distances between the upper and lower eyelids in the rest position.

Conclusion. Europeans have generally larger facial movements than Asians. Particularly the eyebrow, nose and mouth regions show statistically significant larger excursions; exception must be made to the eye region, where Asians have a larger excursion of the eyelids. This is the first step to gather essential information about the ethnical differences in facial movements, a factor that should be considered as FFMT is becoming more popular worldwide.

Reanimation of the paralysed face is becoming more common worldwide. It is important to be aware of ethnic differences in facial movements. Despite research[1–5] to evaluate static dimensions of the human face around the world, ethnic variations in facial dynamics are still not documented.

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Three-dimensional facial movements among Europeans have been reported in a previous study[6] in 2003.

The aim of this study is to document ethnic differences of facial movements between healthy Asians and Europeans, leading to new therapeutic concepts to achieve optimal result in the reanimation of the face. In respect of the heterogeneity within each continent, we selected only individuals born in Taiwan and Austria to achieve uniform population sample for Asian and European subjects.

Materials and methods

The subjects (Asians, $n=24$ and Europeans, $n=24$) were classified into three groups, eight each. The first group consisted of individuals between 20 and 30 years (mean, Asians = 25.0 years $\pm$ 2.73 SD, Europeans = 25.0 years $\pm$ 2.33 SD). Subjects in the second group were between 40 and 50 years (mean, Asians = 44.3 years $\pm$ 2.88 SD, Europeans = 46.8 years $\pm$ 2.53 SD) and the third group consisted of subjects between 60 and 70 years (mean, Asians = 63.0 years $\pm$ 1.41 SD, Europeans = 63.6 years $\pm$ 3.07 SD). In all groups the sexes were equally represented. All 48 subjects were healthy and without craniofacial anomalies. They had never undergone any treatment in the face nor did they have previous histories of paralysis, scars or diseases of the skin. Participants were of East Asian descents, born in Taiwan and Middle European descents, born in Austria.

The data acquisition system[7] consisted of a mirror system, a calibration grid and a commercial digital video camera. Eighteen standardised reproducible anatomic landmarks[7] in the face were chosen, of which three were static and 15 dynamic (Table 1, Fig. 1). A permanent marker was used to place a 2 mm central black dot in locations of the dynamic landmarks. Static points were marked with a self-adjacent plastic light ball of 5 mm in diameter. All markings, except the points, central nose and philtrum, were arranged on both sides of the face.

Each subject was videotaped under standardised conditions. All recordings were done in the same room, in the same chair, by the same examiner and at the same time, which was in the afternoon, between 2.00 and 4.00 pm. Light from four halogen photo-optic lamps 1000 W (Osram, Munich, Germany) were used to generate uniform, symmetrical and standardised lighting. Reflected light from the face was at 5500 lux, measured by a handheld photocell.

Table 1 Abbreviations of standardised facial landmarks

CN	Central nose
LAN	Left ala of the nose
LBR (e.g. BR)	Left brow
LLE	Left lower eyelid
LMC	Left mouth corner
LML	Left midlateral point of the lower lip
LMU	Left midlateral point of the upper lip
LT	Left tragus
LUE	Left upper eyelid
PH	Philtrum
RAN	Right ala of the nose
RBR (e.g. BR)	Right brow
RLE	Right lower eyelid
RMC	Right mouth corner
RML	Right midlateral point of the lower lip
RMU	Right midlateral point of the upper lip
RT	Right tragus
RUE	Right upper eyelid

The videotaped subject sat relaxed and upright in a normal chair without head support, the eyes looked forward into the camera, which was positioned 5 m away from the subject. After positioning the subject into the calibrated measurement field, she/he was instructed to perform the facial movements and then she/he performed the nine standardised facial animations[7] (Table 2) after a verbal signal in a sequential order.

Three trials of each set of facial animations were digitally collected and transferred to a computer, where the most suitable video-sequence out of

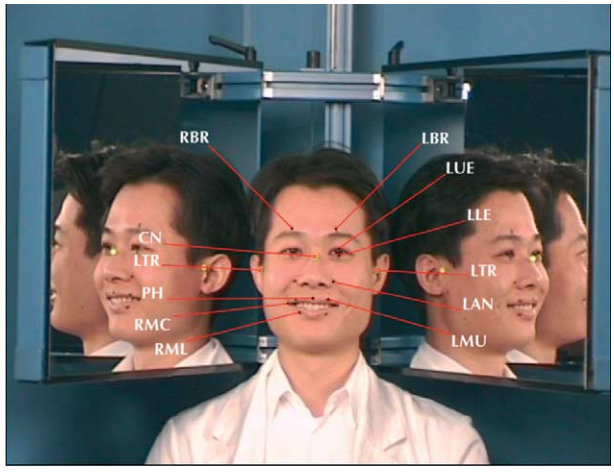

Figure 1 Placements of dynamic (yellow) and static (black) landmarks on a subject, sitting in the mirror complex.

Table 2 Abbreviations of standardised animations, performed by all subjects in sequential order as shown above

English version	Abbreviations	German version
Maximal lifting of the eyebrows	mha	Maximales Heben der Augenbrauen
Closure of the eyelids as in sleep	sas	Schliesen der Augen wie im Schlaf
Maximal closure of the eyelids	ml	Maximaler Lidschluss
Maximal showing of the teeth	mzz	Maximales Zähnezeigen
Maximal showing of the teeth and maximal closure of the eyelids together	mlmz	Gleichzeitig Maximaler Lidschluss und Maximales Zähnezeigen
Smiling with showing teeth	lzz	Lächeln mit Zeigen der Zähne
Smiling with lips closed	lgl	Lächeln mit geschlossenen Lippen
Pursing of the lips	mzp	Mund zuspitzen und pfeifen
Pulling down the mouth corners	mwu	Mundwinkel nach unten ziehen

three was edited and saved as video (.avi) and image (.uis) files to the hard disk. Subsequently Facialis® software[7] (Laboratory for Biomechanics of the Swiss Federal Institute of Technology, Zurich, Switzerland) was used to calculate the three-dimensional coordinates of landmarks in the face. FaciShow® (Laboratory for Biomechanics of the Swiss Federal Institute of Technology, Zurich, Switzerland) was a specially designed program[7] to visualise data processed with the Facialis® software. Two- and three-dimensional trajectories of each single landmark in movement could be presented (Fig. 2(a) and (b)).

All statistical analyses were performed at the Department of Medical Computer Sciences, at the University of Vienna, General Hospital, Vienna. The tests were exploratory in nature, thus no multiple adjustments were performed. Comparisons between two groups are performed by the Student's *t*-test after checking the homogeneity of their variances. Differences between more than two groups were tested by the usual F-test of a one-way analysis of variance (ANOVA). *P*-values lower-equal 0.05 are considered as statistically significant.

Results

In general Europeans ($n=24$) were observed to have larger facial movements than Asians ($n=24$), from 0.4 mm (e.g. 5.7%) up to 3.9 mm (e.g. 37.1%), on average 1.3 mm (e.g. 20.6%) (Table 3a).

Particularly the frontal, nose and mouth regions show statistically significant larger excursions among Europeans (Table 3a); for the frontal region (BR–CN, brow point–central nose point, at maximal lifting of the eye brow) on average 1.4 mm excursion of the eye brow (e.g. 19.9% percentage change from the resting distance, European/Asians, 7.8 mm $\pm$2.31 SD/6.2 mm $\pm$2.31 SD, e.g. 18.7/12.8 percentage change from the resting distance, $p<0.05$), for the nose region (AN–CN, ala of the nose point–central nose point, at smiling with showing teeth) 1.3 mm excursion of the ala of the nose (e.g. 34.6%, European/Asians, 3.8 mm $\pm$2.25 SD/2.5 mm $\pm$0.99 SD, e.g. 8.7/6.1 percentage change from the resting distance, $p<0.05$) and for the mouth region (MC–TR, mouth corner point–tragus point, at smiling with showing teeth) 3.0 mm excursion of the mouth corner (e.g. 30.3%, European/Asians, 12.9 mm $\pm$4.48 SD/8.9 mm $\pm$3.70 SD, e.g. 11.7/7.9 percentage change from the resting distance, $p<0.05$).

One exception is observed in the eye region (Table 3a), where Asians have a larger excursion of the eyelids (1.4 mm, e.g. 15.8%, European/Asians, 7.6 mm $\pm$1.13 SD/9.0 mm $\pm$1.35 SD, $p<0.05$), due to the wider distance between lower and upper eyelid in the resting position.

Gender

European male subjects ($n=12$) had in general larger movements than Asian male subjects ($n=12$), on average 1.79 mm (e.g. 25.12%). A statistically significant difference was only found at the movement 'smiling with showing teeth' (Table 3a) between the points TR–MC (tragus point–mouth corner point), where the movement was 6.4 mm (e.g. 38.7%) larger among Europeans than Asians (European Males/Asian Males, 14.0 mm $\pm$5.44 SD/8.6 mm $\pm$3.34 SD, e.g. 12.2/7.0 percentage change from the resting distance, $p<0.05$).

European females ($n=12$) were seen to have larger facial movements than Asian females ($n=12$) on average 0.96 mm (e.g. 16.1%), from 0.01 mm (e.g. 0.17%) up to 2.4 mm (e.g. 37.02%), but no statistical significance could be found.

Asian males were observed to have 1.0 mm (10.8%) larger distance between lower and upper

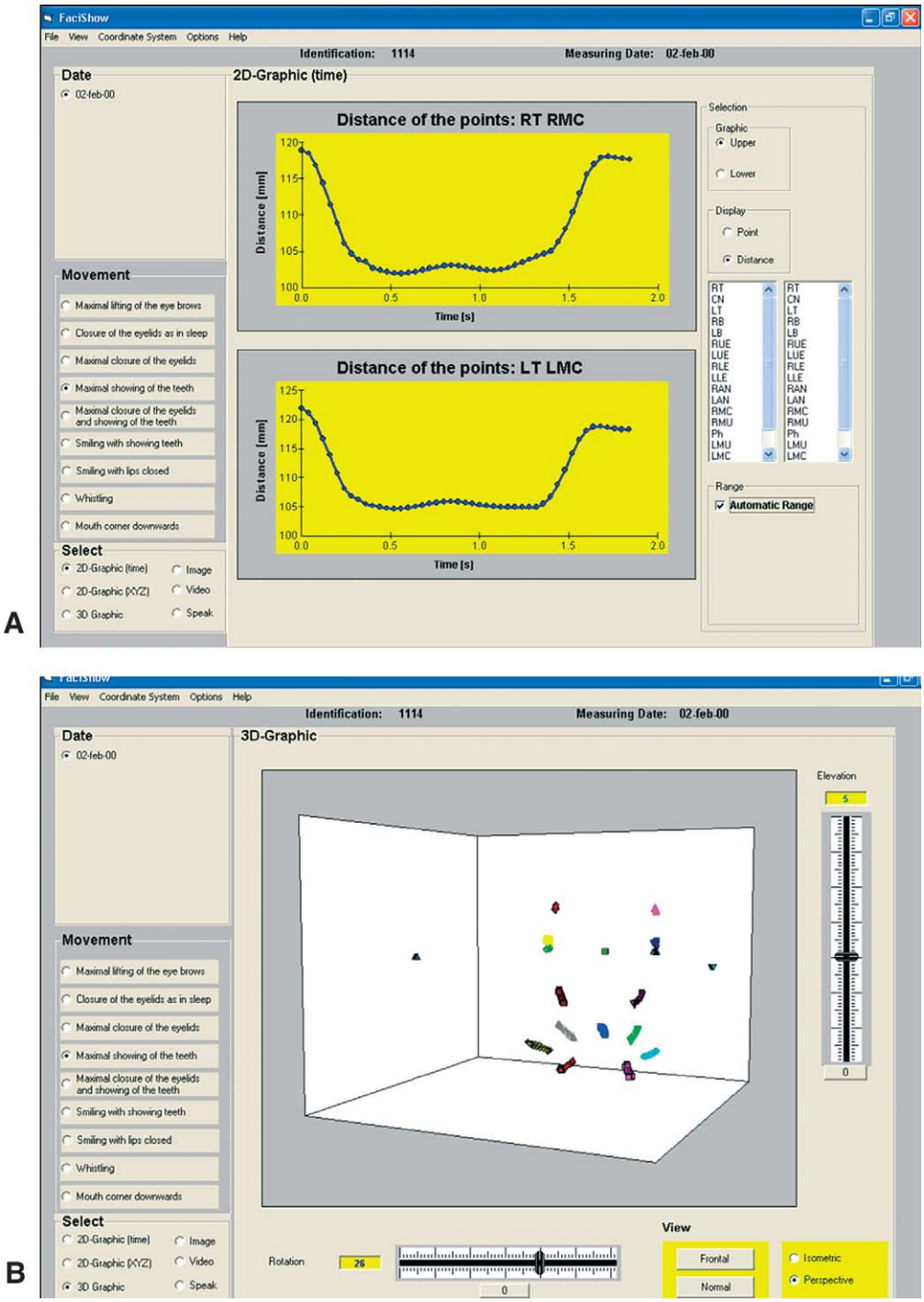

Figure 2 (A) FaciShow®, visualisation of distances between landmarks (right tragus (RTR)—right mouth corner (RMC) and left tragus (LTG)—left mouth corner (LMC) points) during the movement maximal showing of the teeth, points represent the movement (mm) of the landmark per time (seconds). (B). FaciShow®, visualisation of the excursions of each landmark during the whole movement maximal showing of the teeth in a perspective three-dimensional view.

eyelids than European males (European males/Asian males, 7.9 mm ± 0.98 SD/8.9 mm ± 1.07 SD, $p < 0.05$). Female Asians subjects had 1.9 mm (e.g. 20.8%) larger distance between the eyelids than European females (European females/Asian females, 7.2 mm ± 1.20 SD/9.1 mm ± 1.62 SD, $p < 0.05$).

Age groups

In the first age group (20–30 years) Europeans ($n = 8$) had larger facial movements than Asians ($n = 8$), from 0.2 mm (e.g. 2.8%) up to 2.7 mm (e.g. 41.9%), on average of 0.92 mm (e.g. 14.4%) (Table 3b).

Statistically significant differences were also observed in the mouth region, where Europeans show larger movement (2.7 mm, e.g. 28.1%) of the philtrum, at the distance MC–PH (mouth corner point–philtrum point) than Asians at the movement maximal showing teeth (European/Asians, 12.7 mm ± 2.5 SD/10.0 mm ± 1.9 SD, e.g. 35.6/29.4 percentage change from the resting distance, $p < 0.05$). Statistically significant differences were seen in the nose region (Table 3b), where Europeans show larger movement (1.8 mm, e.g. 41.9%) of the ala of the nose, at the distance CN–AN (central nose point–ala of the nose point) than Asians at the movement maximal showing teeth (European/Asians, 4.4 mm ± 1.67 SD/2.5 mm ± 0.72 SD, e.g. 11.02/6.15 percentage change from the resting distance, $p < 0.05$).

In the second age group (40–50 years) facial movements were commonly larger among Europeans ($n = 8$) than Asians ($n = 8$), ranging from 0.1 mm (e.g. 2.0%) up to 4.5 mm (e.g. 41.1%), on average of 1.5 mm (e.g. 24.4%) (Table 3b). Statistically significant larger movement in this age group was observed at smiling with showing teeth. European had on average 4.5 mm (e.g. 36.5%, $p < 0.05$) larger excursion than Asians of the mouth corner at the distance TR–MC (tragus point–mouth corner point) at the movement smiling with showing teeth (European/Asians, 12.3 mm ± 4.26 SD/7.8 mm ± 3.45 SD, e.g. 11.1/6.8 percentage change from the resting distance, $p < 0.05$).

In the third age group (60–70 years), European subjects were also found to have larger facial movements than Asian subjects, which were from 0.2 mm (e.g. 3.2%) up to 6.0 mm (e.g. 58.0%), on average 1.9 mm (e.g. 27.1%) (Table 3b). Statistically significant differences were seen in the frontal, nose and mouth regions. In the frontal region, the mean difference was 2.7 mm (e.g. 30.2%), here Europeans had larger movement of the eyebrows (BR–CN) than Asians at 'maximal lifting of the eyebrows' (European/Asians, 8.9 mm ± 2.92 SD/6.2 mm ± 2.42 SD, e.g. 23.3/12.4 percentage change from the resting distance, $p < 0.05$) (Table 3b). Europeans also showed a larger excursion of the ala of the nose point (AN) of 2.9 mm (e.g. 52.4%) than Asians, at the movement smiling with showing teeth (European/Asians, 5.6 mm ± 2.85 SD/2.6 mm ± 0.90 SD, e.g. 12.1/6.7 percentage change from the resting distance, $p < 0.05$) (Table 3b). In the mouth region, Europeans were observed to have the largest movement of the mouth corner at smiling with showing teeth in this age group, too, which was on average 6.0 mm (e.g. 39.7%) larger than Asians (European/Asians, 15.0 mm ± 5.24 SD/9.1 mm ± 3.82 SD, e.g. 13.5/8.2 percentage change from the resting distance, $p < 0.05$) (Table 3b).

Exception must be made for one particular movement in the age groups, 'closing the eyelids as in sleep'. At this facial movement Asians continually demonstrated larger movement of the eyelids than Europeans, which was on average 1.4 mm (e.g. 7.9%). The mean difference between Europeans and Asians in the first age group was 0.4 mm (e.g. 5.5%, European/Asians, 7.9 mm ± 1.44 SD/8.3 mm ± 0.84 SD), 2.7 mm* (e.g. 40.7%, European/Asians, 6.7 mm ± 0.74 SD/9.5 mm ± 1.91 SD, $^*p < 0.05$) for the second and 1.1 mm* (e.g. 13.7%, European/Asians, 8.1 mm ± 0.59 SD/9.2 mm ± 0.88 SD, $^*p < 0.05$) for the oldest age group.

Side differences

Each of the 48 subjects demonstrated a side difference between the right and the left side of the face. In the evaluation of side differences, the mean distances of right and left were compared. In general, the Asian subjects had larger side differences at facial movements.

Asian subjects showed a side difference from 0.7 mm up to 2.8/3.0% up to 19.7% mm (mean 1.52 mm ± 0.77 SD, e.g. 9.5%) compared to European subjects, 0.8 mm up to 2.6/0.3% up to 9.6% (mean 1.26 mm ± 0.51 SD, e.g. 4.9%).

Asians were seen to have more frequent larger right side of the face than their left sides; on contrary Europeans, had more frequent larger left side of the face than their right sides.

Statistically, significant side difference was observed between Europeans and Asians at the movement 'maximal showing teeth' at the distance MC–PH (mouth corner point–philtrum point), European/Asians, 1.3 mm ± 1.10 SD/2.2 mm ± 1.27 SD, e.g. 4.6/6.3 percentage change from the resting distance, $p < 0.05$.

Gender

In general, the Asian males and females had larger side difference at facial movements compared to Europeans; the mean difference between Asian males and European males ranged from 0.1 up to 3.4 mm, on average 0.8 mm (e.g. 29.8%) and that between Asian females and European females from 0.1 up to 1.1 mm, on average 0.3 mm (e.g. 19.3%) (Table 4a).

Facial movements among Europeans showed a mean side difference from 0.7 up to 2.7 mm (Table 4a) (males from 0.7 to 2.5 mm/0.1–10.0%, females from 0.7 to 2.7 mm/0.8–9.1%).

Facial movements among Asians showed a mean

Table 3a Mean distances (mm) in resting position D(0) and excursion for males and females (Asians = 24, Europeans = 24)

Frontal Region	*D (0)*		
(AT) BP - CN	42.6	43.9	41.2
(TW) BP - CN	49.3	49.9	48.8

Maximal Lifting of the eyebrows		
7.8	8.6	7.0
6.2	6.9	5.5

Legends			
(AT) European	*Males & Females*	*Males*	*Females*
(TW) Asian	*Males & Females*	*Males*	*Females*

Eye Region	*D (0)*		
(AT) UE - LE	7.6	7.9	7.2
(TW) UE - LE	9.0	8.9	9.1

Closure of eyelids as in sleep		
7.6	8.0	7.2
9.0	8.9	9.1

Nose / Mouth	*D (0)*			*Smiling with lips closed*			*Maximal showing of the teeth*			*Smiling with showing teeth*			*Pursing of the lips*		
(AT) TR - MC	109.0	113.3	104.8	9.0	10.3	7.6	15.1	16.5	13.7	12.9	14.0	11.7	10.9	10.0	11.8
(TW) TR - MC	114.3	120.8	107.7	7.5	7.5	7.6	14.5	14.3	14.7	9.0	8.6	9.3	10.2	10.5	10.0
(AT) CN- AN	43.5	45.9	41.0	2.5	2.6	2.4	5.9	6.9	4.9	3.8	4.5	3.1			
(TW) CN- AN	40.6	42.1	39.1	2.0	1.6	2.4	3.7	4.4	3.0	2.5	2.2	2.8			
(AT) CN- MU	66.4	70.5	62.3	3.4	3.8	3.0	6.8	8.0	5.6	5.3	5.9	4.7			
(TW) CN- MU	61.7	64.8	58.5	2.1	2.2	2.1	5.4	6.2	4.5	4.4	4.9	3.9			
(AT) TR - PH	134.3	139.2	129.3	2.8	3.1	2.4	5.6	6.0	5.2	4.1	4.6	3.6			
(TW) TR - PH	137.8	144.6	131.0	2.2	2.1	2.3	5.7	6.4	5.0	4.5	5.4	3.6			
(AT) CN - ML	77.1	80.6	73.5	4.6	5.4	3.8	7.7	8.3	7.1	5.6	6.2	4.9			
(TW) CN - ML	74.5	77.7	71.4	3.2	3.7	2.7	7.9	10.4	5.4	5.0	5.8	4.1			
(AT) MC - PH	36.3	37.6	35.1										7.0	6.3	7.7
(TW) MC - PH	36.4	37.2	35.5										6.6	6.1	7.0

Table 3b Mean distances (mm) in resting position D(0) and excursion for all age groups (Asians = 24, Europeans = 24)

Frontal Region	*D (0)*		
(AT) BP - CN	43.8	44.6	39.3
(TW) BP - CN	47.9	49.7	50.5

Maximal Lifting of the eyebrows		
7.1	7.3	8.9
6.6	5.8	6.2

Legends			
(AT) European	*20-30a*	*40-50a*	*60-70a*
(TW) Asian	*20-30a*	*40-50a*	*60-70a*

Eye Region	*D (0)*		
(AT) UE - LE	7.9	6.7	8.1
(TW) UE - LE	8.3	9.5	9.2

Closure of eyelids as in sleep		
7.9	6.7	8.1
8.3	9.5	9.2

Nose / Mouth	*D (0)*			*Smiling with lips closed*			*Maximal showing of the teeth*			*Smiling with showing teeth*			*Pursing of the lips*		
(AT) TR - MC	109.2	110.0	107.9	8.8	8.8	9.3	16.0	13.9	15.5	11.3	12.3	15.0	9.6	12.4	10.8
(TW) TR - MC	118.2	113.0	111.6	8.2	7.3	7.1	14.8	14.1	14.5	10.0	7.8	9.1	9.3	11.6	9.8
(AT) CN- AN	41.1	43.4	45.9	2.1	2.0	3.5	4.4	5.5	7.7	2.5	3.2	5.6			
(TW) CN- AN	41.2	40.9	39.8	1.6	2.4	1.9	2.5	4.0	4.6	2.4	2.4	2.6			
(AT) CN- MU	61.6	67.0	70.7	2.7	3.1	4.4	5.3	6.8	8.2	4.1	4.3	7.5			
(TW) CN- MU	60.5	63.4	61.2	2.0	1.9	2.5	4.2	5.4	6.5	3.9	4.2	5.1			
(AT) TR - PH	133.4	135.0	134.5	2.3	2.2	3.7	5.1	5.0	6.7	3.3	4.3	4.6			
(TW) TR - PH	140.0	138.3	135.3	2.5	1.5	2.5	4.4	6.4	6.3	6.5	2.5	4.5			
(AT) CN - ML	73.6	78.0	79.6	4.1	3.7	6.1	9.1	7.0	6.9	5.0	5.0	6.7			
(TW) CN - ML	74.8	75.9	73.0	3.9	3.2	2.6	6.6	8.1	9.0	5.4	3.8	5.7			
(AT) MC - PH	36.0	36.1	37.0										6.2	7.1	7.6
(TW) MC - PH	34.2	37.5	37.0										5.4	7.6	6.7

side difference from 0.3 up to 4.3 mm (Table 4a) (males from 0.9 to 4.3 mm/0.1–26.3%, females from 0.6 to 2.5 mm/1.2–12.4%).

Statistically significant larger side difference was observed among Asian male subjects in the mouth region, at the distance TR–PH (tragus point–philtrum point) at the movement maximal showing teeth (European males/Asians males, 0.9 mm ± 0.63 SD/2.1 mm ± 1.50 SD, e.g. 0.6/1.3 percentage change from the resting distance, $p < 0.05$).

Statistically significant larger side difference was also observed among Asian female subjects in the mouth region, at the distance MC–PH (mouth corner point–philtrum point) at the movement maximal showing teeth (European females/Asians males, 1.4 mm ± 1.11 SD/2.5 mm ± 0.87 SD, e.g. 5.1/7.1 percentage change from the resting distance, $p < 0.05$).

Age groups

In general, the subjects of the Asian age groups had larger side difference at facial movements compared to Europeans; the mean difference between Asians and Europeans in the first age group (20–30 years) ranged from 0.1 up to 4.4 mm, on average 1.0 mm (e.g. 34.8%), in the second age group (40–50 years) ranged from 0.2 up to 3.5 mm, on average 0.8 mm (e.g. 36.7%) and that in the third age group (60–70 years) ranged from 0.3 up to 1.6 mm, on average 0.7 mm (e.g. 21.1%).

Facial movements among Europeans age groups showed a mean side difference from 0.6 up to 3.2 mm (Table 4b), (0.5 up to 2.8 mm/1.5–7.0% in the first age group, in the second age group from 0.6 till 3.2 mm/6.0–20.2% and in the third age group from 0.7 to 3.1 mm/3.3–13.6%).

Mean side differences at facial movement among the Asian age groups ranged from 0.6 up to 5.6 mm (Table 4b), (subjects in the 20s from 0.5 up to 5.6 mm/2.0–20.8%, subjects in the 40s from 0.6 mm till 4.5 mm/2.1–30.8% and subjects in the 60s from 0.6 to 3.2 mm/1.0–22.4%).

Statistically significant side difference between Europeans and Asians were seen in the first (20–30 years) and third age (60–70 years) groups. Asians in the first age group larger side difference in the mouth region, at the distance MC–PH (mouth corner point–philtrum point) at the movement smiling with showing teeth (European/Asians, 0.5 mm ± 0.48 SD/1.2 mm ± 0.67 SD, e.g. 2.4/2.7 percentage change from the resting distance, $p < 0.05$). For subjects in the third age group, Asians also showed larger side difference in the mouth region, at the distance TR–MC (tragus point–mouth corner point) at the movement maximal showing teeth (European/Asians, 1.6 mm ± 1.34 SD/3.2 mm ± 1.01 SD, e.g. 1.4/2.8 percentage change from the resting distance, $p < 0.05$).

Discussion

Population sample

It has been said that each of the three major geographic races—African, Asian, and European—has evolved a characteristic set of facial features,[8] confirmed by anthropometric research.[9–11] They reported that one ethnic group is predominant in several European countries (e.g., France, Germany, Italy, Spain, Scandinavia, Czech Republic, Hungary, and Poland) compared to the multi-ethnic population in North America. Therefore, in creating a representative population sample, the study of facial movements consisted only of subjects from Middle European[6] and East Asian descent. Particularly, individuals born in the eastern part of Austria and in Taiwan were selected to take part in this study.

Three-dimensional system

This study determined ethnic differences of facial movements among healthy European and Asian subjects, applying the objective three-dimensional video-analysis technique.[7] This system used a mirror system, a calibration grid, a digital video camera, an analysis software (Facialis®) and visualisation software (FaciShow®) to seize all facial dimensions and movements of interest. This method to assess the extremely complex facial movements offered adequate and objective results.[12] This standardised three-dimensional video-analysis system is able to visualise the exact coordinates of each point determined in the mirror complex, as seen in previous studies.[6,7,12,13] It was also able to illustrate velocity and direction of each landmark within the three-dimensional space of interest.

Standardised procedures

In order to maximally eliminate errors from all aspects, all procedures in this study were standardised. Reproducible and standardised landmarks[7] were selected and marked in the face, which have been set up and standardised in the International Registry for Neuromuscular Reconstruction in the Face, founded in 1994.[12] This three-dimensional video-analysis system has been introduced to report facial nerve function recovery, to monitor facial

reanimation results (before and after surgery) and to determine standard values for healthy facial movements.[6] It was applied in clinical routine, at the Division of Plastic and Reconstructive Surgery, Department of Surgery, General Hospital, Vienna, since 1998. Moreover an international multi-center study (Canada, Denmark and Italy) has been initialised in 2000, collecting and analyzing different operative concepts and alternative operative techniques in the reanimation of the face around the world.

Mean facial movements

Generally, ethnic origin seems to have an impact on facial movements. We observed that Europeans in general showed larger facial movements than Asians, which was on average 1.3 mm (e.g. 20.6%). European males were observed to have on average 1.79 mm (25.12%) larger facial movements than Asians, statistically significant larger facial movements were in the mouth region, where the mouth corner showed a 6.4 mm (e.g. 38.7%) larger movement at smiling with showing teeth than Asian males.

These findings support the common impression that Asians have less vivid facial expressions and movements compared to the Caucasian race. Asians represent the 'stiller' face. The stiller face might be due to unaccountable factors, which are cultural differences, educational differences, differences in approach how to behave in the society (e.g. Asians are taught to be reserved in the public) and differences of the skin thickness, to mention some.

Lee[14] reported that Koreans epidermal thickness accounts for 8.3% of the depth of the whole skin, whereas in Caucasians it accounts for only 4.1%. Thus due to the thinner skin among Caucasians and the increased thinning of the epidermis atrophied with age,[15] lose of elasticity, stiffen of collagen fibers,[16] and the impact of the long term gravity exposure, causing surplus skin, may result in larger excursions of landmarks at facial movements, especially in old age.

However, facial movements among Asians are inversely proportional with their facial anatomy. Anthropometric study[2] shows that Asians have wider and longer skulls than Caucasians, but Asians have smaller facial movements than Europeans. Hajnis et al.[2] report that the width, determined by the distance between the right and left zygion point (zy, the most lateral point of each zygomatic arch) of Asian males/females was on average 144.6 mm $\pm$ 5.6 SD/136.2 mm $\pm$ 4.0 SD and that of Caucasian male/female face is on average 139.6 mm $\pm$ 5.2 SD/131.2 mm $\pm$ 4.4 SD. The length of the face is measured between the landmarks nasion point (n, the point in the midline of both the nasal root and the nasofrontal suture) and gnathion point (gn, lowest median landmark on the lower border of the mandible), where Asians are observed to have a mean length of 123.6 mm $\pm$ 5.3 SD among males and 114.9 mm $\pm$ 4.9 SD for females. Caucasians have a shorter face than Asians, which was on average 116.5 mm $\pm$ 6.1 SD for males and 110.3 mm $\pm$ 5.2 SD for females. Due to larger skull dimensions, we assumed Asian subjects to have larger and stronger facial muscles, e.g. larger facial movements. However, the findings in this study did not confirm our assumptions.

Studies of muscle strength[17] and quality of muscle fibers[18] of Europeans were carried out in the past. Still among Asians, these need to be studied to see comparable differences, if any, between these two ethnicities.

Gender

In recent researches about facial movements,[6,19,20] men are found to have statistically significant larger movements than women. This might be due to the larger growth of male facial musculature and skull as compared with the lighter features of the female face, which was reported to be about four-fifths the size of men's.[9,21]

This study accord with the finding mentioned above, where males show wider faces than females among Asians and Caucasians. The width of the face in this study is representable through the distance between the right and left tragus point (RTR–LTR). It shows a noticeable difference between males and females among Asians and Caucasians. The width of the face among Asians is on average 164.1 mm $\pm$ 6.01 SD for males and 155.5 mm $\pm$ 5.63 SD for females. Caucasians are observed to have similar difference between the sexes, where the mean width of the face among males is 162.2 mm $\pm$ 5.76 SD and that for females is 149.4 mm $\pm$ 4.76 SD). Anthropometric studies[2,9] confirm the finding in this study, that differences among sexes are statistically significant, which can be pursued in various ethnicities.[2]

Age

Statistically significant differences in the age groups can be clearly seen between Asians and Caucasians in excursions around the nose and mouth region, particularly ala of the nose point and mouth corner point. In the first age group (20–30a), Europeans are observed to have on

Table 4a Side difference (mm) in resting position D(0) and excursion for all subjects (Asians = 24, Europeans = 24)

Frontal Region	*D (0)*		
(AT) BP - CN	3.0	3.4	2.7
(TW) BP - CN	2.5	3.1	1.8

Maximal Lifting of the eyebrows		
1.1	1.2	1.0
1.2	1.2	1.2

Legends			
(AT) European	*Males & Females*	*Males*	*Females*
(TW) Asian	*Males & Females*	*Males*	*Females*

Eye Region	*D (0)*		
(AT) UE - LE	0.8	0.8	0.8
(TW) UE - LE	0.7	0.9	0.6

Closure of eyelids as in sleep		
0.8	0.8	0.8
0.7	0.9	0.6

Nose / Mouth	*D (0)*		
(AT) TR - MC	3.8	4.3	3.3
(TW) TR - MC	5.6	5.6	5.6
(AT) CN- AN	1.8	1.6	2.0
(TW) CN- AN	2.1	2.2	2.1
(AT) CN- MU	1.2	1.3	1.1
(TW) CN- MU	2.3	2.4	2.1
(AT) TR - PH	3.8	4.3	3.2
(TW) TR - PH	5.3	4.7	6.0
(AT) CN - ML	1.0	1.3	0.7
(TW) CN - ML	1.4	1.7	1.1
(AT) MC - PH	2.0	1.8	2.1
(TW) MC - PH	2.3	2.2	2.5

Smiling with lips closed			*Maximal showing of the teeth*			*Smiling with showing teeth*			*Pursing of the lips*		
1.9	2.4	1.3	2.1	2.1	2.1	2.6	2.5	2.7	2.1	2.0	2.2
1.5	1.5	1.5	2.3	2.1	2.4	2.5	3.1	1.9	2.4	2.9	1.8
0.9	0.8	1.0	1.4	1.5	1.3	1.1	1.1	1.1			
1.2	1.0	1.4	1.1	1.2	1.0	1.0	1.0	1.0			
0.8	0.8	0.8	1.4	1.4	1.3	1.0	1.0	1.0			
1.1	1.2	0.9	1.3	1.4	1.2	2.2	3.5	1.0			
0.8	0.8	0.8	1.2	1.0	1.4	0.9	0.9	0.9			
0.9	1.0	0.8	1.7	2.1	1.3	2.7	4.3	1.2			
0.8	1.0	0.7	1.3	1.3	1.3	1.0	0.7	1.2			
1.0	1.2	0.8	1.4	2.0	0.9	0.9	1.0	0.8			
									1.2	0.9	1.4
									1.1	1.2	1.1

Table 4b Side difference (mm) in resting position D(0) and excursion for all age groups (Asians = 24, Europeans = 24)

Frontal Region	*D (0)*		
(AT) BP - CN	2.7	4.2	2.1
(TW) BP - CN	2.5	2.4	2.6

Maximal Lifting of the eyebrows		
0.7	1.1	1.4
1.1	0.9	1.7

Legends			
(AT) European	*20-30a*	*40-50a*	*60-70a*
(TW) Asian	*20-30a*	*40-50a*	*60-70a*

Eye Region	*D (0)*		
(AT) UE - LE	1.0	0.7	0.7
(TW) UE - LE	0.5	0.8	0.9

Closure of eyelids as in sleep		
1.0	0.7	0.7
0.5	0.8	0.9

Nose / Mouth	*D (0)*			*Smiling with lips closed*			*Maximal showing of the teeth*			*Smiling with showing teeth*			*Pursing of the lips*		
(AT) TR - MC	3.2	5.0	3.1	2.4	1.4	1.8	2.1	2.4	1.6	2.8	1.9	3.1	1.4	3.2	1.7
(TW) TR - MC	5.0	6.9	3.6	1.4	2.0	1.1	1.8	1.8	3.2	3.3	2.1	2.2	0.9	3.2	3.0
(AT) CN- AN	1.0	1.9	2.5	0.7	0.9	1.1	1.2	1.0	1.9	0.8	1.1	1.4			
(TW) CN- AN	2.2	3.0	1.2	0.8	1.8	1.0	1.0	1.0	1.2	0.9	0.8	1.4			
(AT) CN- MU	0.9	1.2	1.5	0.7	0.7	1.0	0.9	1.4	1.7	1.0	1.1	0.9			
(TW) CN- MU	1.5	3.8	1.6	1.2	1.0	1.0	0.8	2.1	1.1	0.9	4.5	1.3			
(AT) TR - PH	3.7	3.7	3.9	0.9	0.8	0.7	1.5	0.7	1.4	1.1	0.8	0.8			
(TW) TR - PH	5.2	7.7	3.0	0.8	1.2	0.7	1.1	1.5	2.4	5.6	1.4	1.3			
(AT) CN - ML	1.0	0.9	1.2	0.9	0.8	0.9	0.6	1.7	1.5	1.1	0.8	1.0			
(TW) CN - ML	1.4	1.7	1.1	0.8	1.3	0.9	2.2	1.0	1.1	1.4	0.6	0.6			
(AT) MC - PH	1.6	2.4	1.6										0.9	1.6	1.0
(TW) MC - PH	2.0	3.6	1.7										0.9	1.1	1.4

average 0.9 mm (e.g. 14.4%) larger facial movements than Asians; as in the second age group (40–50a) the difference average out 1.5 mm (e.g. 24.4%) and in the third age group (60–70a) the mean difference is 1.9 mm (e.g. 27.1%).

As mentioned before thinner epidermis[14] among Caucasians, increased thinning of the atrophied epidermis with age,[15] lose of elasticity, stiffen of collagen fibers,[16] and the impact of the long term gravity exposure on earth, might result in larger excursions of landmarks at facial movements, especially in old age. Larger facial movements among Europeans in all age groups than Asians might also be due in their nature, as depicted above.

Side difference

Side difference in facial motion is a common finding in this study. Asian subjects show a side difference from 0.7 mm up to 2.8/3.0% up to 19.7% mm (mean 1.52 mm $\pm$0.77 SD, e.g. 9.5%) compared to European subjects, 0.8 mm up to 2.6/0.3% up to 9.6% (mean 1.26 mm $\pm$0.51 SD, e.g. 4.9%). Our finding correlate with the results of recent studies, where dynamic side differences are also found in the study of Scriba et al. (1999).[22] They consider a side difference of 7–9% at movements to be physiological. Side differences in facial movements are also observed by Ferrario et al. (1994),[23] which is evident especially in the middle and lower parts of face, but neither absolute nor relative measurements of side difference are available in his results. Ethnic origin seems to have a significant impact on facial dynamics.

In general, Europeans were observed to have larger facial movements than Asians. Particularly, the frontal nose and mouth regions show statistically significant larger excursions among Europeans than Asians. One exception must be made in the eye region, where Asians have a larger excursion of the eyelids, due to the wider distance between lower and upper eyelid in the resting position.

This is the very first step to gather successive information about the ethnic differences in facial movements. Moreover, it gathers healthy values of facial movements, in order to judge the preoperative measurements of facial movements in patients with facial paralysis and their functional recovery progress after reconstructive procedures.

Furthermore, this study gives an essential aspect of the ethnical differences in facial dynamics in international multicenter studies involving Asian and European patients, when reanimation of paralysed faces is becoming more popular worldwide.

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