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Investigation of Class Characteristics in English Handwriting of the Three Main Racial Groups: Chinese, Malay and Indian in Singapore*

ABSTRACT: This paper investigated the class characteristics in English handwriting of the Chinese, Malays and Indians in Singapore, many of whom learned their native language as a second language. One hundred and fifty-four handwriting exemplars were collected and features such as letter designs, pen-lifts, letter spacing and embellishments were studied. A number of characteristic features peculiar to the individual racial group were identified, which confirmed the impact of their native language writing systems on English handwriting.

KEYWORDS: forensic science, questioned documents, class characteristics, handwriting, Chinese, Malay, Indian

The multi-racial society of Singapore provides the authors ample chances in examining English handwriting of different “accent.” Due to the education system emphasizing bilingualism, each child learns English and his or her native language. Thus the three main races, Chinese, Malay and Indian not only learn English but also their own mother language (1). It is common that Chinese children learn Chinese; Malay children learn romanised Malay in school as well as Arabic in mosque and at home; and Indian children learn Tamil. The exposure to a writing system using characters different from the Latin script may give rise to the observed distinctive characteristics made by the different racial groups when writing English. It is one of the authors’ objectives to investigate the class characteristics of their English handwriting and to explore the possible influence from their accustomed hands in writing their native language.

Chinese characters are based on ideograms, which incorporates three important elements: shape, pronunciation and meaning. Regardless of how many strokes they are composed of, each character is written stroke by stroke and designed to fit into the same imaginary square frame (Fig. 1). There are altogether eight basic strokes to form the basic building blocks—radicals and “*bushou*” for Chinese characters. They are:

1. “dian” (a simple dot);
2. “heng” (a horizontal stroke);
3. “shu” (a vertical stroke);
4. “pie” (a diagonal stroke falling from right to left);
5. “tiao” (a diagonal stroke rising from left to right);
6. “zhe” (an angle);
7. “gou” (a hook); and
8. “na” (a diagonal stroke from left to right).

(Please refer to the correspondingly numbered illustration in Fig. 2.)

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In constructing the character, basic rules on the sequence of strokes have to be observed:

1. Make “heng” before “shu”;
2. Make “pie” before “na”;
3. Write from top to bottom;
4. Write from left to right;
5. Write from the outer to the inner if enclosed by three sides;
6. Write from the inner to the outer if enclosed fully by four sides; and
7. Finish the middle part before writing the strokes on two sides (2,3).

Arabic is the language of Qur’ān. The Malays in Singapore, who are mostly Muslims, learn the language for their religious needs. The script is composed of 28 letters (Fig. 3). Their forms and shapes change according to their location in a word. They can occupy four different positions namely initial, medial, final, and isolated.

Unlike English, it is written from right to left (Fig. 4). As it is a cursive script, letters within a word are to be joined as much as possible. Exceptions are the six letters ﻻ ﺏ ﺕ ﺓ ﺓ and ﺓ which never join to the letter that followed. Another characteristic feature of Arabic script is the use of dots, circles, slant strokes or curly strokes as the diacritical marks. They are placed above or below a letter to denote the pronunciation (4,5).

The Tamil writing system is the most common Indian language used and learnt by the Indians in Singapore. It has twelve vowels, 1 aytham and eighteen consonants (Fig. 5). The vowels and the consonants combine to form over 200 letters, and each letter in turn combines to form words (Fig. 6). Tamil is not a cursive script, thus no letters will be joined in writing. As with English writing, it is written from left to right (4,6).

Researches had been conducted in the past to study the class characteristics of handwritings done by foreign trained writers (7–9). Although most findings were positive in identifying a few features to be representative amongst the particular groups of writers, few took the quantitative approach to see if the observed characteristics were of statistical significance.



FIG. 1—All Chinese characters are constructed to fit into an imaginary square.

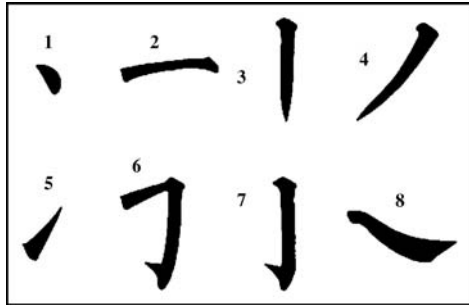


FIG. 2—Eight basic strokes in the formation of Chinese characters. The stroke marked “5” is the only one made in an ascending direction.

Other than identifying the class characteristics of the English handwriting written by the three racial groups, this paper attempts to analyze the data systematically so as to establish a procedure, based on statistical methodology, on the determination of class

characteristics. The authors hope that could these objectives be achieved, the forensic community would be a step closer to the determination of nationality or ethnic origin of writers by examining their handwritings.

Materials and Methods

Invitations for participation in this project were sent out and a total of 154 English writing specimens returned. Of the 154 participants, the distribution of racial groups was as follows: 50 Chinese, 52 Malays and 52 Indians. Their ages ranged between 18 and 60, and they were of different occupation and education levels. All of them attended local primary and secondary schools.

One prepared control passage known widely as the “London Letter” was typed on the top of a sheet of A4 size office paper (Fig. 7). Participants were asked to copy the “London Letter” at the unlined space below. Each of them was provided with a blue ballpoint pen of the same brand.

The handwriting specimens were carefully studied to identify the characteristic features distinctive of the racial group. The number of persons, who exhibited the characteristic feature, and the number of those who did not, were counted. (As not exhibiting the feature was as well a crucial factor in the determination of class characteristics, the number of persons not having the feature found in their handwriting had to be taken into account.) The results were submitted to Chi-square test to check for their statistical significance.

Results and Discussions

The handwriting specimens were studied in detail to look for characteristic features in letter formation, letter design, pen-lift, letter and word spacing and embellishment etc. Many features were

ا	ب	ت	ث	ج	ح	خ
'alif	bâ'	tâ'	thâ'	jîm	hâ'	khâ'
د	ذ	ر	ز	س	ش	ص
dâl	dhâl	râ'	zây	sîn	shîn	sâd
ض	ط	ظ	ع	غ	ف	ق
dâd	tâ'	zâ'	'ayn	ghayn	fâ'	qâf
ك	ل	م	ن	ه	و	ي
kâf	lâm	mîm	nûn	hâ'	wâw	yâ'

FIG. 3—The 28 letters in Arabic script. They may take different form or shape when placed in different locations in a word. The above show their forms when they are on their own.

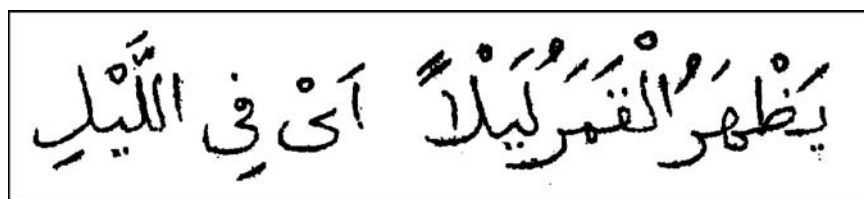


FIG. 4—The script is written from right to left, which is different from that in English.

The 12 vowels:

அ ஆ இ ஈ உ ஊ
எ ஏ ஐ ஒ ஓ ஔ

The Aytham:

ஃ

The 18 Consonants:

க் க் ட் த் ப் ற்
ங் ஞ் ண் ன் ம் ன்
ய் ர் ல் வ் ழ் ள்

FIG. 5—The vowels and consonants combined to form letters. The aytham is used as diacritics.

இவற்றில் நம் வட்டார மொழி, பாரம்பரியப்
பண்பாடுகளும் கலாசாரங்களும் பிரதிபலிப்பதைக்
காணலாம்.

FIG. 6—A Tamil sentence meaning “One can see our culture from this zone”.

“Our London business is good, but Vienna and Berlin are quiet. Mr. D. Lloyd has gone to Switzerland and I hope for good news. He will be there for a week at 1496 Zermott St. and then goes to Turin and Rome and will join Colonel Parry and arrive at Athens, Greece, November 27th or December 2nd. Letters there should be addressed—King James Blvd. 3580. We expect Chas E. Fuller Tuesday. Dr. L. McQuaid and Robt. Unger, Esq., left on the ‘Y.X.’ Express tonight.”

FIG. 7—The “London Letter”. It captures all the twenty-six alphabet letters, both lower and upper case, and also the ten numerals, from 0 to 9.

found, and the ten of highest occurrence were selected to test for their statistical significance:

1. loop formation on the stem of “d”
2. loop formation on the lower part of the stem of “f”
3. loop/hook formation in “S” and “s”
4. curved uppermost horizontal stroke of “T”, “J” and “F”
5. curve-stroke formation of “E”
6. curve-stroke formation of “X”
7. round-top formation of “A”
8. round-bottom formation of “V”

9. sequence of strokes in “T” with the horizontal stroke written first
 10. straight-stroke formation of “M” and “N”
- (Please refer to the correspondingly numbered illustration in Fig. 8a to 8j.)

The Null Hypothesis held that there would be no overall difference among the three racial groups in regards to the occurred frequency of any of the ten characteristic features stated above. Therefore, if the Null Hypothesis were true:

$$P_M = P_I = P_C$$

P is the probability of observing a characteristic feature in the handwriting of the particular race, with M denoting the Malay population; I the Indian population; and C the Chinese population.

The Alternate Hypothesis would then be:

$$P_M \neq P_I \text{ and/or } P_M \neq P_C \text{ and/or } P_C \neq P_I$$

For each characteristic feature, a 3×2 component table was constructed to compute the χ^2 value. The results were tabulated in Table 1. The significance level 0.05 was chosen, which is a commonly accepted level in scientific research studies. At the degree of freedom of 2, the critical value of χ^2 at the significance level 0.05 is



FIG. 8a—Loop formation on the stem of “d”.



FIG. 8b—Loop formation on the lower part of the stem of “f”.

FIG. 8e—Curve-stroke formation of “E”.



FIG. 8c—Loop/hook formation in “S” and “s”.



FIG. 8f—Curve-stroke formation of “X”.



FIG. 8d—Curved uppermost horizontal stroke of “T”, “J” and “F”.



FIG. 8g—Round-top formation of “A”.



FIG. 8h—Round-top formation of “V”.



FIG. 8i—Sequence of strokes in “T” with the horizontal stroke written first.



FIG. 8j—Straight-stroke formation of “M” and “N”.

TABLE 1—Chi-square values of the ten characteristic features. Those exceeded the critical value 5.99 were double-underlined.

Characteristic Features		Malay	Indian	Chinese	Sum of Chi-sq	
Looping on “d” stem	Yes	Observed	33.0	24.0	18.0	<u>8.5</u>
		Expected	25.2	25.2	24.7	
		Chi-sq	2.4	0.1	1.8	
	No	Observed	18.0	27.0	32.0	
		Expected	25.8	25.8	25.3	
		Chi-sq	2.4	0.1	1.8	
Total		51.0	51.0	50.0		
Looping on “f” lower stem	Yes	Observed	29.0	13.0	26.0	<u>11.7</u>
		Expected	22.8	22.8	22.4	
		Chi-sq	1.7	4.2	0.6	
	No	Observed	22.0	38.0	24.0	
		Expected	28.2	28.2	27.6	
		Chi-sq	1.4	3.4	0.5	
Total		51.0	51.0	50.0		
Loop/hook formation in “S” and “s”	Yes	Observed	48.0	39.0	40.0	5.7
		Expected	42.9	42.9	41.2	
		Chi-sq	0.6	0.4	0.0	
	No	Observed	4.0	13.0	10.0	
		Expected	9.1	9.1	8.8	
		Chi-sq	2.9	1.7	0.2	
Total		52.0	52.0	50.0		
Curved upper strokes of “T”, “J” and “F”	Yes	Observed	23.0	18.0	13.0	3.7
		Expected	18.2	18.2	17.5	
		Chi-sq	1.2	0.0	1.2	
	No	Observed	29.0	34.0	37.0	
		Expected	33.8	33.8	32.5	
		Chi-sq	0.7	0.0	0.6	
Total		52.0	52.0	50.0		
Curve-stroke formation of “E”	Yes	Observed	16.0	8.0	7.0	5.6
		Expected	10.5	10.5	10.1	
		Chi-sq	2.9	0.6	0.9	
	No	Observed	36.0	44.0	43.0	
		Expected	41.5	41.5	39.9	
		Chi-sq	0.7	0.1	0.2	
Total		52.0	52.0	50.0		
Curve-stroke formation of “X”	Yes	Observed	6.0	18.0	8.0	<u>9.9</u>
		Expected	10.9	10.7	10.5	
		Chi-sq	2.2	5.0	0.6	
	No	Observed	46.0	33.0	42.0	
		Expected	41.1	40.3	39.5	
		Chi-sq	0.6	1.3	0.2	
Total		52.0	51.0	50.0		
Round-top formation of “A”	Yes	Observed	9.0	21.0	8.0	<u>10.2</u>
		Expected	12.7	12.9	12.4	
		Chi-sq	1.1	5.1	1.6	
	No	Observed	42.0	31.0	42.0	
		Expected	38.3	39.1	37.6	
		Chi-sq	0.4	1.7	0.5	
Total		51.0	52.0	50.0		
Round-bottom formation of “V”	Yes	Observed	14.0	15.0	7.0	3.7
		Expected	12.2	12.2	11.7	
		Chi-sq	0.3	0.7	1.9	
	No	Observed	38.0	37.0	43.0	
		Expected	39.8	39.8	38.3	
		Chi-sq	0.1	0.2	0.6	
Total		52.0	52.0	50.0		
Sequence of strokes in “T” with horizontal stroke made first	Yes	Observed	32.0	30.0	40.0	<u>7.5</u>
		Expected	34.9	31.3	35.8	
		Chi-sq	0.2	0.1	0.5	
	No	Observed	7.0	5.0	0.0	
		Expected	4.1	3.7	4.2	
		Chi-sq	2.0	0.5	4.2	
Total		39.0	35.0	40.0		
Straight-stroke formation of “M”	Yes	Observed	29.0	19.0	30.0	<u>6.4</u>
		Expected	26.7	26.2	25.1	
		Chi-sq	0.2	2.0	0.9	
	No	Observed	23.0	32.0	19.0	
		Expected	25.3	24.8	23.9	
		Chi-sq	0.2	2.1	1.0	
Total		52.0	51.0	49.0		

TABLE 2—Chi-square values of the six characteristic features found to be statistical significant. Those exceeded the critical value 3.84 were double-underlined.

Characteristic Features			Malay	Indian	Sum of Chi-sq	Malay	Chinese	Sum of Chi-sq	Indian	Chinese	Sum of Chi-sq
Looping on “d” stem	Yes	Observed	33.0	24.0	3.2	33.0	18.0	<u>8.3</u>	24.0	18.0	1.3
		Expected	28.5	28.5		25.8	25.2		21.2	20.8	
		Chi-sq	0.7	0.7		2.0	2.1		0.4	0.4	
	No	Observed	18.0	27.0	18.0	32.0	27.0	32.0			
		Expected	22.5	22.5	25.2	24.8	29.8	29.2			
		Chi-sq	0.9	0.9	2.1	2.1	0.3	0.3			
Total		51.0	51.0	51.0	50.0	51.0	50.0				
Looping on “f” lower stem	Yes	Observed	29.0	13.0	<u>10.4</u>	29.0	26.0	0.2	13.0	26.0	<u>7.5</u>
		Expected	21.0	21.0		27.8	27.2		19.7	19.3	
		Chi-sq	3.0	3.0		0.1	0.1		2.3	2.3	
	No	Observed	22.0	38.0	22.0	24.0	38.0	24.0			
		Expected	30.0	30.0	23.2	22.8	31.3	30.7			
		Chi-sq	2.1	2.1	0.1	0.1	1.4	1.5			
Total		51.0	51.0	51.0	50.0	51.0	50.0				
Curve-stroke formation of “X”	Yes	Observed	6.0	18.0	<u>8.1</u>	6.0	8.0	0.4	18.0	8.0	<u>4.9</u>
		Expected	12.1	11.9		7.1	6.9		13.1	12.9	
		Chi-sq	3.1	3.1		0.2	0.2		1.8	1.8	
	No	Observed	46.0	33.0	46.0	42.0	33.0	42.0			
		Expected	39.9	39.1	44.9	43.1	37.9	37.1			
		Chi-sq	0.9	1.0	0.0	0.0	0.6	0.6			
Total		52.0	51.0	52.0	50.0	51.0	50.0				
Round-top formation of “A”	Yes	Observed	9.0	21.0	<u>6.4</u>	9.0	8.0	0.0	21.0	8.0	<u>7.4</u>
		Expected	14.9	15.1		8.6	8.4		14.8	14.2	
		Chi-sq	2.3	2.3		0.0	0.0		2.6	2.7	
	No	Observed	42.0	31.0	42.0	42.0	31.0	42.0			
		Expected	36.1	36.9	42.4	41.6	37.2	35.8			
		Chi-sq	0.9	0.9	0.0	0.0	1.0	1.1			
Total		51.0	52.0	51.0	50.0	52.0	50.0				
Sequence of stroke in “T” with horizontal stroke made first	Yes	Observed	32.0	30.0	0.2	32.0	40.0	<u>7.9</u>	30.0	40.0	<u>6.1</u>
		Expected	32.7	29.3		35.5	36.5		32.7	37.3	
		Chi-sq	0.0	0.0		0.4	0.3		0.2	0.2	
	No	Observed	7.0	5.0	7.0	0.0	5.0	0.0			
		Expected	6.3	5.7	3.5	3.5	2.3	2.7			
		Chi-sq	0.1	0.1	3.6	3.5	3.0	2.7			
Total		39.0	35.0	39.0	40.0	35.0	40.0				
Straight-stroke formation of “M” and “N”	Yes	Observed	29.0	19.0	3.5	29.0	30.0	0.3	19.0	30.0	<u>5.7</u>
		Expected	24.2	23.8		30.4	28.6		25.0	24.0	
		Chi-sq	0.9	1.0		0.1	0.1		1.4	1.5	
	No	Observed	23.0	32.0	23.0	19.0	32.0	19.0			
		Expected	27.8	27.2	21.6	20.4	26.0	25.0			
		Chi-sq	0.8	0.8	0.1	0.1	1.4	1.4			
Total		52.0	51.0	52.0	49.0	51.0	49.0				

5.99 (rounded up to 3 significant Figs.) (10). The Null Hypothesis would be rejected should the χ^2 value be greater than 5.99.

Six characteristic features were found to have χ^2 values higher than 5.99, which mean these observed results were significant beyond 0.05 level. They were:

1. loop formation on the stem of “d”
2. loop formation on the lower part of the stem of “f”
3. curve-stroke formation of “X”
4. round-top formation of “A”
5. sequence of strokes in “T” with the horizontal stroke written first
6. straight-stroke formation of “M” and “N”

As Chi-square test is non-directional in nature, it is necessary to submit the results to the test again to find out the inference group of the six characteristic features. So for every of the six

characteristic features, each population was to compare with the other two separately. A 2×2 component table was constructed to compute the χ^2 value, and the results were summarized in Table 2. With the significance level set at 0.05 and the degree of freedom at 1, the critical value of χ^2 would be equal to 3.84 (rounded up to 3 significant figures). A computed value which was larger than 3.84 denoted its statistical significance.

The results were found to be as follows:

- A. Inference set: Malays, Chinese and Indians in Singapore
 - i. The curve-stroke formation of “X” and the round-top formation of “A” were found to be the class characteristics in the English handwriting of Indians (Fig. 9a).
 - ii. The sequence of strokes in “T” with the horizontal stroke written first was found to be the class characteristic in the English handwriting of Chinese (Fig. 9b).
 - iii. The loop formation on the lower part of the stem of “f” was found to be the class characteristic in the English handwriting of Chinese and Malays (Fig. 9c).

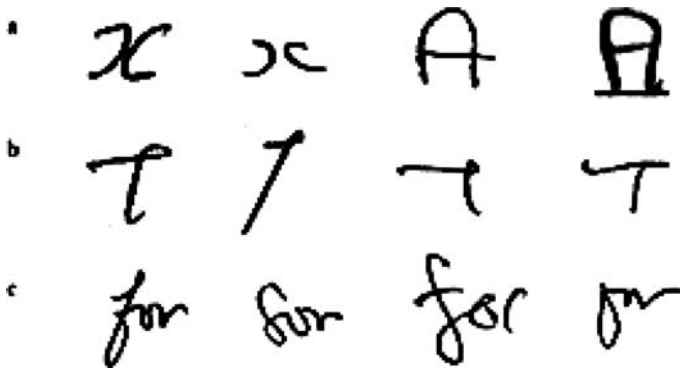


FIG. 9—Characteristic features for the inference set – Malays, Indians and Chinese in Singapore.



FIG. 10—Characteristic features for the inference set – Malays and Chinese in Singapore.



FIG. 11—Characteristic features for the inference set – Indians and Chinese in Singapore.

- B. Inference set: Malays and Chinese in Singapore
 - i. The loop formation on the stem of “d” was found to be the class characteristic in the English handwriting of Malays (Fig. 10).
- C. Inference set: Indians and Chinese in Singapore
 - i. The straight-stroke formation of “M” and “N” was found to be the class characteristic in the English handwriting of Chinese (Fig. 11).

English writing done by Indians in Singapore was characterized by the square appearances (Fig. 12a). The closeness in width and height used in letter construction infused uniformity into the writing. Letters within a word were not extensively connected, and this inevitably abated the rhythm and smoothness. It was noted that letter size was generally bigger and the writing was less slanted when compared to those done by Chinese and Malay.

One of the factors that contributed to the square appearances was the adoption of flat-top (or round-top) and flat-bottom (or round-bottom) letter design. The pointed apex of “A” was replaced with broad, round roof, and the pointed vertex of “W” and “V” were replaced with long, shallow trough. The letters “m” and “n”, both uppercase and lowercase, were constructed arcade-like. Similarly, the top and bottom strokes of uppercase “D”, “G”, “R” and lowercase “b”, “c”, “o”, “u” or “s” were broad and flat or slightly curved.

Indian writers preferred to use long, broad strokes with a slight curvature. For instance, the descenders of “y” and “g” shaped like a salad bowl, with the downward strokes being round and long forming a slightly curved trough. And for the formation of “x”, two straight crossing strokes were replaced with two curved strokes. It

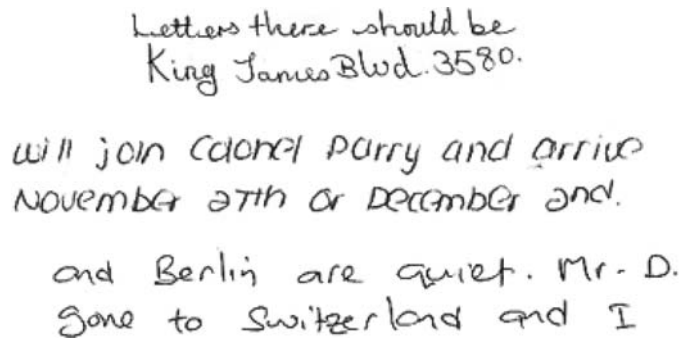


FIG. 12a—English handwriting of three Indian writers. The sizes of the loops in alphabet letters such as “a”, “o” and “d” were relatively large and their shapes were round and oval.

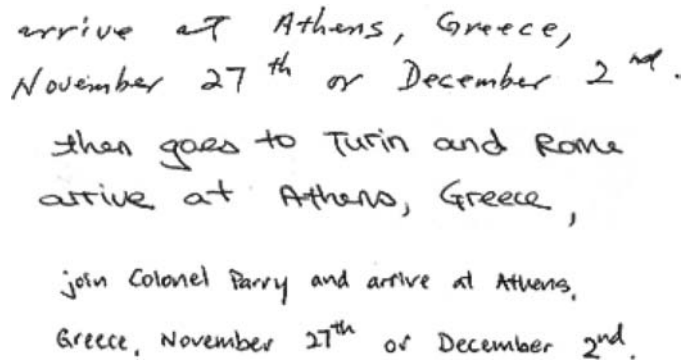


FIG. 12b—English handwriting of three Chinese writers.

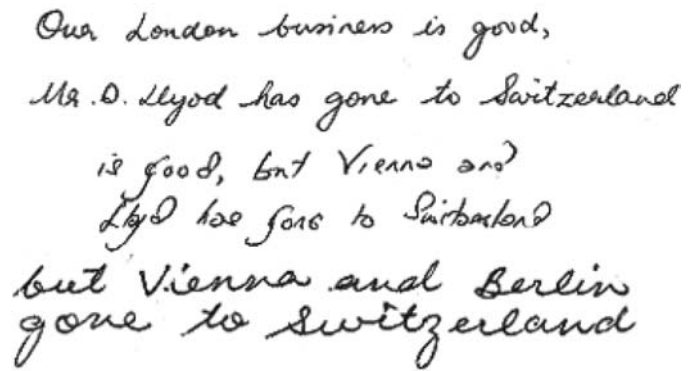


FIG. 12c—English handwriting of three Malay writers. More embellishments were found in their letter design.

was not common to see wedges, sharp and pointed turnings or lines crossing each other with acute angles in their letter design.

Tamil letters were formed by long strokes running through left and right and up and down to complete the design. The strokes were mostly flat or slightly curved. The use of circles and dots were moderate when compared to Arabic script. The observed characteristic feature on their preferred use of long and round strokes in the English handwriting could be due to their accustomed hands in writing Tamil letters.

The authors had also noted that Indian writers tended to leave a wide spacing after the punctuation marks comma and full stop. The gap was found to be wider than the normal word spacing. Further study is needed to verify if this is another of their class characteristics.



FIG. 13—The Chinese character “ren” with the sequence of stroke formation marked in numerical order.

English writing done by Chinese shared the common feature of angular appearance (Fig. 12*b*). The group preferred to use straight strokes and wedge-shaped loops and ornamental features were few. Connection strokes were mostly straight and angular, and this imparted inflexibility to the overall appearance. Although the writing was fluent, it lacked the rhythm and liveliness that could usually be found in the English writing done by Malays.

Many people describe Chinese characters as “Fang Kuai Zi”, which means “Square characters”. So it was not surprising when the English handwriting of the Chinese writers was found to bear the same overall square and angular appearance. In fact, the accustomed hand not only affected the appearance but also the sequence of strokes. For instance, all Chinese writers participating in this study wrote the horizontal stroke in “T” first. This could be influenced by their habitual construction of Chinese character with strokes written in a descending direction. (Fig. 13)

Another possible impact could be the many hiatuses in their English writing. Chinese characters were constructed stroke by stroke, and there was no connection between characters in daily use Chinese writing. Possibly influenced by this habit, pen-lifts were observed in every two or three letters within a word in their English handwriting.

Chinese writers tended to complete the letter design in the simplest way. Just as the descenders of “y” and “g”, a simple downward straight stroke was common. And as mentioned above their preference in forming angles in letter formation, wedge shaped “M” and “N” or pointed “A” could easily be found in their writing.

For the writing habit of forming a loop on the stem of “f”, there was no apparent connection with their accustomed hands in writing Chinese characters. They might have retained what they were taught in the early days of schooling on how to write cursive “f”.

The general appearance of English handwriting by Malays was smooth, and most often aesthetically done. Unlike the Chinese writers, Malays liked to use round curves in their letter formation, and special letter design and embellishments were common. Letters were joined with upwardly curved connection strokes in a rhythmic and skillful manner. There were very few hiatuses between letters. Loops and circles in letter formation were broad and round, which injected uniformity to the passage (Fig. 12*c*).

The incorporation of loops and circles into the letter formation and design was a common feature in their writing. Loops could be found on the “d” stem, on the “u” arms, on the rising “r” arm and at the pointed centre of “M” or on its slanted strokes. They could also be found tying around the “f” stem, the “i” stem or the “p” stem (Fig. 14).

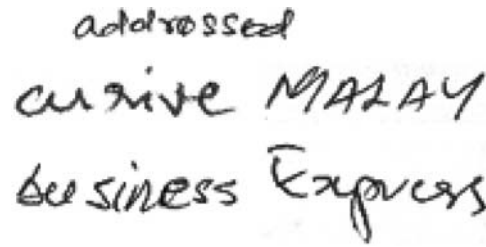


FIG. 14—Malay writers commonly used loops and circles as part of the letter design.

It was also found that most of the curved strokes, circles or loops were constructed in an anti-clockwise direction. Although Arabic script runs from right to left, it seemed that no significant impact was imparted to the direction of letter formation in their English handwriting. Very few letters were found to be constructed in clockwise direction.

Conclusion

The study has established a procedure, based on statistical methodology, on the determination of class characteristics in English handwriting of the three major racial groups in Singapore. Six class characteristics were identified, and their occurrences could be attributed to the habitual influence from writing their own native language: Chinese, Tamil and Arabic. By using the established procedure, document examiners will be able to determine the class characteristics in English handwriting of different racial groups, and possibly the determination of nationality or ethnic origins of writers.

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