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Original Article

Forensic Examination of Class Characteristics in English Handwriting of the Three States: Andhra Pradesh, Punjab and Kashmir in India

الفحص الجنائي للخصائص الطبقية للكتابة الإنجليزية بخط اليد في ثلاث ولايات في الهند: أندرا براديش والبنجاب وكشمير

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Abstract

The present study analyzed the English handwriting of subjects from Andhra Pradesh, Punjab and Jammu and Kashmir to investigate whether the examination of style characteristics helps determine the nationality/ethnicity of the writer or the place where the writer learned writing.

The subjects had completed secondary education in their respective regional languages along with English as a second language. Characteristic features such as letter formations, punctuation marks, spacing between letters, and margins were observed. The data were analysed using the chi- square test to determine significant class characteristics in the English handwritings.

Significant class characteristics were identified; these occurrences were attributable to the influence of habitually writing in their native language, because the impact of regional language on the subject's English handwriting was observed in a few samples.

Forensic document examiners will be able to determine class characteristic in the English handwritings of people from different states using the established procedure and possibly also determine the nationality or ethnic origin of writers.

Keywords: *Forensic Sciences, Handwriting Statistical Significance, Class Characteristics, India*

المستخلص

في الهند، يتعلم الجميع التحدث وكتابة لغتهم الأصلية إلى جانب اللغة الإنجليزية. لذلك، يتعرض الجميع إلى نظامين مختلفين للكتابة. وحللت الدراسة الحالية الكتابة اليدوية الإنجليزية لأشخاص من ولاية اندرا براديش والبنجاب وكشمير لبحث إذا ما كان فحص خصائص الأسلوب يساعد في تحديد الجنسية/العرق للكاتب أو المكان الذي تعلم فيه الكاتب الكتابة.

أكمل الأشخاص المشاركون في الدراسة التعليم الثانوي بلغاتهم الإقليمية جنباً إلى جنب مع اللغة الإنجليزية كلغة ثانية. ولوحظت خصائص مميزة مثل أشكال الحروف وعلامات الترقيم والتباعد بين الحروف والهوامش.

وحللت البيانات باستخدام اختبار مربع كاي لتحديد ما إذا كان هناك خصائص طبقية كبيرة في كتابات اللغة الإنجليزية. وحددت بعض الخصائص الطبقية تتميز بفروقات ذات دلالة إحصائية. ويُعزى حدوثها إلى تأثير الكتابة المعتادة في لغتهم الأصلية، لأنه لوحظ أثر اللغة الإقليمية على الكتابة اليدوية للإنجليزية في بعض العينات. وتساعد النتائج فاحصو الأدلة الجنائية من تحديد الخصائص الطبقية في كتابات اللغة الإنجليزية للأشخاص من ولايات مختلفة باستخدام الإجراء المتبع وربما تحديد الجنسية أو الأصل العرقي للكاتب.

الكلمات المفتاحية: علوم الأدلة الجنائية، الدلائل الإحصائية في الكتابات اليدوية، الخصائص الطبقية، الهند.

1. Introduction

India is a land of numerous languages and has been called a 'tower of veritable languages'. Each Indian state has its own dialect that is used while both speaking and writing. Every person learns to speak and write their own native language and script along with English. For example, the Telugu and Gurumukhi scripts are used in Andhra Pradesh and Punjab, respectively, along with English. Kashmiri and Urdu scripts are used in Jammu and Kashmir along with English. Writing systems help to distinguish the writer from a group of writers or differentiate him from writers of other systems [1- 3]. A review of the literature shows that different research has been conducted on this subject. Jasuja et al. [4] analyzed the class characteristics of the Gurumukhi script of the Punjabi population. Turner et al. [5] determined class characteristics of the Gurumukhi script in handwritings of first and second generation Punjabis in the United Kingdom. Cheng et al. [6] and Shah and Dahiya [7] established a procedure based on a statistical method for determination of nationality or ethnic origin of writers in English handwriting by different writers. Turnbull et al. [8] studied class characteristics in the English handwriting of Polish and English people.

This study focused on determining the significant class characteristics of people from different states and the influence of their native language and scripts on their English handwriting.

2. Materials and Methods

Three hundred handwriting specimens were collected from subjects in the three Indian states: Andhra Pradesh, Punjab, and Jammu and Kashmir. The subjects were asked to write passages consisting of alphabets and diacritic marks on separate A4 sheets with their favoured hands. They were asked to write the paragraph four times. The subjects included both men and women above 18 years of age who were acquainted with English (Roman script) and had completed secondary education in their regional languages (Telugu, Kashmiri or Urdu and Gurumukhi) in their native states. Figure-1 shows the Telugu and Gurumukhi scripts [9,10] and the native scripts of Andhra Pradesh and Punjab, respectively. Figure-2 shows Kashmiri and urdu scripts [11,12] used in Jammu and Kashmir. Additional information about the subjects, such as their educational qualifications, the class level at which they began to learn English, and their average writing habit per day was also obtained with their consent.
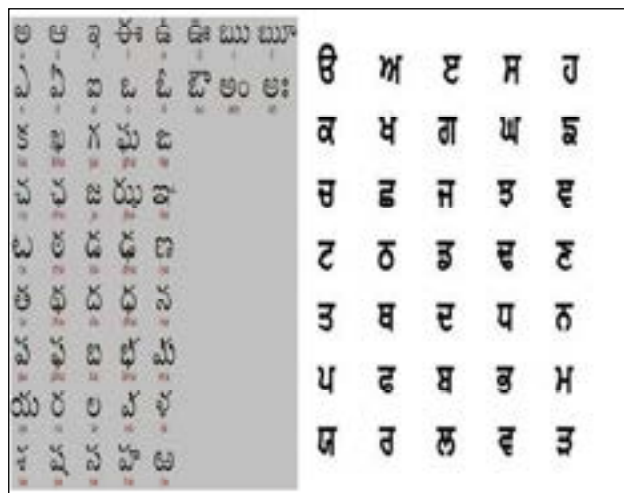

Figure 1- *Telugu and Gurumukhi scripts [9, 10].*

Figure 2- *Kashmiri and Urdu scripts [10, 11].*

The handwriting specimens were carefully examined to identify the distinctive features of respondents of different states. The following characteristics were examined:

1. Margins
2. Punctuation marks and 'i' and 'j' dots (form and placing)
3. Spacing between letters and punctuation marks
4. Letter forms:
   - Loop/hook formation in 's' and 'S'
   - "h" and "k" having loop at top
   - Loop formation on the stem of 'd'
   - 'd' with stem and circle
   - Loop formation on lower part of the stem of 'f'
   - Loop formation on the upper part of the stem of 'f'
   - Round top formation of 'A'
   - 'b' written as '6'
   - 't' crossings

The respondents, who exhibited (present) the characteristic feature and those who do not (absent) were counted as two different parameters. The observed data were coded to binary variables 0 and 1 for the absent and present of characteristic features, respectively. This is an important factor in the evaluation of class characteristics. The data were analyzed using Chi-Square test to find out significant characteristic features of English handwriting of three Indian states.

3. Results and Discussion

Three hundred handwriting samples (100 respondents each from Andhra Pradesh, Punjab, and Jammu and Kashmir) were examined for various characteristics in English handwriting. Pearson Chi- Square Test was applied on the data and found to be useful in finding significant features of the three States. The null hypothesis held that there is no overall difference in the handwritings of respondents from three states. If the null hypothesis is true:

$P(A)=P(K) = P(Pu)$

Where, P is the probability of observing a characteristic feature in English handwriting of subjects. 'A' denotes Andhra Pradesh, 'K' denotes Jammu and Kashmir and 'Pu' denotes Punjab.

The alternate hypothesis would be:

$P(A) \neq P(K) \neq P(Pu)$

For each characteristic feature, 3*2 component table was constructed to compute Chi-Square value with the significance level set at 0.05.The results were tabulated. Table-1 shows chi-square values of statistically significant characteristics; that exceeded the value 5.99. At the degree of freedom 2, the critical value of Chi-Square would be 5.99 (rounded up to 3 significant features). If the tested characteristic features had a sum of Chi-Square value greater than 5.99, the null hypothesis would be rejected; that is, the characteristic feature is of significance in that group.

Furthermore, to find out the inference group of all characteristic features, each state was compared with the other two states separately. For each characteristic feature, 2*2 component table was constructed to compute Chi-Square with the significance level chosen (0.05). The results were tabulated. Table-2 shows Chi-square values of statistically significant characteristic features; that exceeded the value 3.84. For the degree of freedom 1, the critical value of Chi-Square would be 3.84 (rounded up to 3 significant features). The computed value of sum of Chi-Square that is larger than 3.84 denoted statistical significance of the particular characteristic feature which proved the significance of the results.

The following features were found to be significant class characteristics of above mentioned States:

Table 1- *Chi-square values of statistically significant characteristic feature that exceeded the value 5.99.*

Characteristic Features			Andhra Pradesh	Kashmir	Punjab	Sum of chi square	*p*-value
1. Loop formation on stem of ' d'	Yes	Observed	21	34	11	15.5	0.0
		Expected	22	22	22		
		Chi-square	0.0	6.5	5.5		
	No	Observed	79	66	89		
		Expected	78	78	78		
		Chi-square	0.0	1.8	1.6		
2. Loop formation on lower part of stem of 'f'	Yes	Observed	42	47	67	14.0	0.0
		Expected	52	52	52		
		Chi-square	1.9	0.5	4.3		
	No	Observed	58	53	53		
		Expected	48	48	48		
		Chi-square	2.1	0.5	4.7		
3. Loop formation on upper part of stem of 'f'	Yes	Observed	29	49	58	17.8	0.0
		Expected	45.3	45.3	45.3		
		Chi-square	5.9	0.3	3.5		
	No	Observed	71	51	42		
		Expected	54.7	54.7	54.7		
		Chi-square	4.9	0.2	2.9		
4. Loop formation on 's'	Yes	Observed	25	46	19	19.1	0.0
		Expected	30.0	30.0	30.0		
		Chi-square	0.8	8.5	4.0		
	No	Observed	75	54	81		
		Expected	70.0	70.0	70.0		
		Chi-square	0.4	3.7	1.7		
5. Hook formation in 's'	Yes	Observed	37	36	31	0.9	0.6
		Expected	34.3	34.7	34.7		
		Chi-square	0.2	0.1	0.4		
	No	Observed	63	64	69		
		Expected	65.3	65.3	65.3		
		Chi-square	0.1	0.0	0.2		
6.'b' written as '6'	Yes	Observed	37	21	60	32.2	0.0
		Expected	39.3	39.3	39.3		
		Chi-square	0.1	8.5	10.9		
	No	Observed	63	79	40		
		Expected	60.7	60.7	60.7		
		Chi-square	0.1	5.5	7.0		

Table 1 - (continued)

Characteristic Features			Andhra Pradesh	Kashmir	Punjab	Sum of chi square	p-value
7.'d' with stem and circle	Yes	Observed	63	59	41	11.1	0.0
		Expected	54.3	54.3	54.3		
		Chi-square	1.4	0.4	3.3		
	No	Observed	37	41	59		
		Expected	45.7	45.7	45.7		
		Chi-square	1.6	0.5	3.9		
8. Round top formation of 'A'	Yes	Observed	12	12	36	24.0	0.0
		Expected	20.0	20.0	20.0		
		Chi-square	3.2	3.2	12.8		
	No	Observed	88	88	64		
		Expected	80.0	80.0	64		
		Chi-square	0.8	0.8	3.2		
9. 'h' having loop at top	Yes	Observed	16	31	27	6.5	0.0
		Expected	24.7	24.7	24.7		
		Chi-square	3.0	1.6	0.2		
	No	Observed	84	69	73		
		Expected	75.3	75.3	75.3		
		Chi-square	10	0.5	0.1		
10. 'k' having loop at top	Yes	Observed	5	20	19	11.2	0.0
		Expected	14.7	14.7	14.7		
		Chi-square	6.4	1.9	1.3		
	No	Observed	95	80	81		
		Expected	85.3	85.3	85.3		
		Chi-square	1.1	0.3	0.2		
11.'a' with hiatus	Yes	Observed	14	10	17	-	-
		Expected					
		Chi-square					
	No	Observed	86	90	83		
		Expected					
		Chi-square					
12.'t' written as '+'	Yes	Observed	60	16	48	42.7	0.0
		Expected	41.3	41.3	41.3		
		Chi-square	8.4	15.5	1.1		
	No	Observed	40	84	52		
		Expected	58.7	58.7	58.7		
		Chi-square	5.9	10.9	0.8		

Table 1 - (continued)

Characteristic Features			Andhra Pradesh	Kashmir	Punjab	Sum of chi square	p-value
13.Upper 't' crossing	Yes	Observed	23	7	27	68.9	0.0
		Expected	41.7	41.7	41.7		
		Chi-square	8.4	20.7	5.2		
	No	Observed	77	25	73		
		Expected	58.3	58.3	58.3		
		Chi-square	6.0	19.0	3.7		
14. Middle 't' crossing	Yes	Observed	77	25	50	54.1	0.0
		Expected	50.7	50.7	50.7		
		Chi-square	13.7	13.0	0.0		
	No	Observed	23	75	50		
		Expected	49.3	49.3	49.3		
		Chi-square	14.1	13.4	0.0		
15. Lower 't' crossing	Yes	Observed	0	0	7	14.3	0.0
		Expected	2.3	2.3	2.3		
		Chi-square	2.3	2.3	9.3		
	No	Observed	100	100	93		
		Expected	97.7	97.7	97.7		
		Chi-square	0.1	0.1	0.2		
16. Upper to middle 't' crossing	Yes	Observed	0	0	10	20.7	0.0
		Expected	3.3	3.3	3.3		
		Chi-square	96.7	96.7	96.7		
	No	Observed	100	100	90		
		Expected	96.7	96.7	96.7		
		Chi-square	0.1	0.1	0.5		
17. Middle to lower 't' crossing	Yes	Observed	0	0	6	12.2	0.0
		Expected	2.0	2.0	2.0		
		Chi-square	2.0	2.0	8.0		
	No	Observed	100	100	94		
		Expected	98.0	98.0	98.0		
		Chi-square	0.0	0.0	0.2		
18. Margins left, top right present	Yes	Observed	0	8	22	27.6	0.0
		Expected	10.0	10	10		
		Chi-square	10.0	0.4	14.4		
	No	Observed	100	92	78		
		Expected	90.0	90.0	90.0		
		Chi-square	1.1	0.0	1.6		

Table 1 - (continued)

Characteristic Features			Andhra Pradesh	Kashmir	Punjab	Sum of chi square	*p*-value
19. Margins left and top present	Yes	Observed	17	40	44	19.0	0.0
		Expected	33.7	33.7	33.7		
		Chi-square	8.3	1.2	3.2		
	No	Observed	83	60	56		
		Expected	66.3	66.3	66.3		
		Chi-square	4.2	0.6	1.6		
20. Margins left and right present	Yes	Observed	60	0	0	150.0	0.0
		Expected	20.0	20.0	20.0		
		Chi-square	80.0	80.0	80.0		
	No	Observed	40	100	100		
		Expected	80.0	80.0	80.0		
		Chi-square	20	5	5		
21. Margins top and right present	Yes	Observed	0	0	6	12.2	0.0
		Expected	2.0	2.0	2.0		
		Chi-square	2.0	2.0	8.0		
	No	Observed	100	100	94		
		Expected	98.0	98.0	98.0		
		Chi-square	0.0	0.0	0.2		
22.Margins present at top	Yes	Observed	10	21	51	45.3	0.0
		Expected	27.3	27.3	27.3		
		Chi-square	11.0	1.5	20.5		
	No	Observed	90	79	49		
		Expected	72.7	72.7	72.7		
		Chi-square	4.1	0.6	7.7		
23. Margins present at left	Yes	Observed	2	9	3	6.5	0.0
		Expected	4.7	4.7	4.7		
		Chi-square	1.5	4.1	0.6		
	No	Observed	98	91	97		
		Expected	95.3	95.3	95.3		
		Chi-square	0.1	0.2	0.0		
24. No margins	Yes	Observed	11	22	10	7.2	0.0
		Expected	14.3	14.3	14.3		
		Chi-square	0.8	4.1	1.3		
	No	Observed	89	78	90		
		Expected	85.7	85.7	85.7		
		Chi-square	0.1	0.7	0.2		

Table 2- *Chi-square values of statistically significant characteristic feature that exceeded the value 3.84.*

Characteristics			Andhra Pradesh	Kashmir	Sum of χ2	Andhra Pradesh	Punjab	Sum of χ2	Kashmir	Punjab	Sum of χ2
1. Loop formation on stem of ' d'	Yes	Observed	21	34		21	11		34	11	
		Expected	27.5	27.5		16.0	16.0		22.5	22.5	
		Chi-square	1.5	1.5	4.2	1.6	1.6	3.7	5.9	5.9	15.2
	No	Observed	79	66		79	89		66	89	
		Expected	72.5	72.5		84.0	84.0		77.5	77.5	
		Chi-square	0.6	0.6		0.3	0.3		1.7	1.7	
2. Loop formation on lower part of stem of 'f'	Yes	Observed	42	67		42	67		47	67	
		Expected	54.5	54.5		54.5	54.5		57.0	57.0	
		Chi-square	2.9	2.9	0.5	2.9	2.9	12.6	1.8	1.8	8.2
	No	Observed	58	33		58	33		53	33	
		Expected	45.5	45.5		45.5	45.5		43.0	43.0	
		Chi-square	3.4	3.4		3.4	3.4		2.3	2.3	
3. Loop formation on upper part of stem of 'f'	Yes	Observed	29	49		29	58		49	58	
		Expected	39.0	39.0		43.5	43.5		53.5	53.5	
		Chi-square	2.6	2.6	8.4	4.8	4.8	17.1	0.4	0.4	1.6
	No	Observed	71	51		71	42		51	42	
		Expected	61.0	61.0		56.5	56.5		46.5	46.5	
		Chi-square	1.6	1.6		3.7	3.7		0.4	0.4	
4. Loop formation on 's'	Yes	Observed	25	46		25	19		46	19	
		Expected	35.5	35.5		22.0	22.0		32.5	32.5	
		Chi-square	3.1	3.1	9.6	0.4	0.4	1.0	5.6	5.6	16.6
	No	Observed	75	54		75	81		54	81	
		Expected	64.5	64.5		78.0	78.0		67.5	67.5	
		Chi-square	1.7	1.7		0.1	0.1		2.7	2.7	
5. Hook formation in 's'	Yes	Observed	37	36		37	31		36	31	
		Expected	36.5	36.5		34.0	34.0		33.5	33.5	
		Chi-square	0.0	0.0	0.0	0.3	0.3	0.8	0.2	0.2	0.6
	No	Observed	63	64		63	69		64	69	
		Expected	63.5	63.5		66.0	66.0		66.5	66.5	
		Chi-square	0.0	0.0		0.1	0.1		0.1	0.1	
6. 'b' written as '6'	Yes	Observed	37	21		37	60		21	60	
		Expected	29.0	29.0		48.5	48.5		-	-	
		Chi-square	2.2	2.2	6.2	2.7	2.7	10.6	-	-	31.6
	No	Observed	63	79		63	40		79	40	
		Expected	71.0	71.0		51.5	51.5		-	-	
		Chi-square	0.9	0.9		2.6	2.6		-	-	

Table 2 - (continued)

Character-istics			Andhra Pradesh	Kash-mir	Sum of χ2	Andhra Pradesh	Punjab	Sum of χ2	Kash-mir	Pun-jab	Sum of χ2
7. 'd' with stem and circle	Yes	Observed	63	59		63	41		59	41	
		Expected	61.0	61.0		52.0	52.0		50.0	50.0	
		Chi-square	0.1	0.1	0.3	2.3	2.3	9.7	1.6	1.6	6.5
	No	Observed	37	41		37	59		41	59	
		Expected	39.0	39.0		48.0	48.0		50.0	50.0	
		Chi-square	0.1	0.1		2.5	2.5		1.6	1.6	
8. Round top forma-tion of 'A'	Yes	Observed	12	12		12	36		12	36	
		Expected	12.0	12.0		24.0	24.0		24.0	24.0	
		Chi-square	0.0	0.0	0.0	6.0	6.0	15.8	6.0	6.0	15.8
	No	Observed	88	88		88	64		88	64	
		Expected	88.0	88.0		76.0	76.0		76.0	76.0	
		Chi-square	0.0	0.0		1.9	1.9		1.9	1.9	
9. 'h' hav-ing loop at top	Yes	Observed	16	31		16	27		31	27	
		Expected	23.5	23.5		21.5	21.5		30.5	30.5	
		Chi-square	2.4	2.4	6.3	1.4	1.4	3.6	0.0	0.0	0.0
	No	Observed	84	69		81	73		69	63	
		Expected	76.5	76.5		78.5	78.5		69.5	69.5	
		Chi-square	0.7	0.7		0.4	0.4		0.0	0.0	
10. 'k' hav-ing loop at top	Yes	Observed	5	20		5	19		20	19	
		Expected	12.5	12.5		12.0	12.0		19.5	19.5	
		Chi-square	4.5	4.5	10.3	4.1	4.1	9.3	0.0	0.0	0.0
	No	Observed	95	80		95	81		80	81	
		Expected	87.5	87.5		88.0	88.0		80.5	80.5	
		Chi-square	0.6	0.6		0.6	0.6		0.0	0.0	
11. 'a' with hiatus	Yes	Observed	14	10		14	17		10	17	
		Expected	12.0	12.0		15.5	15.5		3.5`	13.5	
		Chi-square	0.3	0.3	0.8	0.1	0.1	0.3	0.9	0.9	2.1
	No	Observed	86	90		86	83		90	83	
		Expected	88.0	88.0		84.5	84.5		86.5	86.5	
		Chi-square	0.0	0.0		0.0	0.0		0.1	0.1	
12. 't' writ-ten as '+'	Yes	Observed	60	16		60	48		16	48	
		Expected	38.0	38.0		54.0	54.0		32.0	32.0	
		Chi-square	12.7	12.7	41.1	0.7	0.7	2.9	8.0	8.0	23.5
	No	Observed	40	84		40	52		84	52	
		Expected	62.0	62.0		46.0	46.0		68.0	68.0	
		Chi-square	7.8	7.8		0.8	0.8		3.8	3.8	

Table 2 - (continued)

Character-istics			Andhra Pradesh	Kash-mir	Sum of χ2	Andhra Pradesh	Punjab	Sum of χ2	Kash-mir	Pun-jab	Sum of χ2
13. Upper 't' crossing	Yes	Observed	23	75		23	27		75	27	
		Expected	49.0	49.0		25.0	25.0		51.0	51.0	
		Chi-square	13.8	13.8	54.1	0.2	0.2	0.4	11.3	11.3	46.1
	No	Observed	77	25		77	73		25	73	
		Expected	51.0	51.0		75.0	75.0		490	49.0	
		Chi-square	13.3	13.3		0.1	0.1		11.8	11.8	
14. Middle 't' crossing	Yes	Observed	77	25		77	50		25	50	
		Expected	51.0	51.0		63.5	63.5		37.5	37.5	
		Chi-square	13.3	13.3	54.1	2.9	2.9	15.7	4.2	4.2	13.3
	No	Observed	23	75		23	50		75	50	
		Expected	49.0	49.0		36.5	36.5		62.5	62.5	
		Chi-square	13.8	13.8		5.0	5.0		2.5	2.5	
15. Lower 't' crossing	Yes	Observed	0	0		0	7		0	7	
		Expected	0	0		3.5	3.5		3.5	3.5	
		Chi-square	0	0	0	3.5	3.5	7.3	3.5	3.5	7.3
	No	Observed	100	100		100	93		100	93	
		Expected	100	100		96.5	96.5		96.5	96.5	
		Chi-square	0	0		0.1	0.1		0.1	0.1	
16. Upper to middle 't' crossing	Yes	Observed	0	0		0	10		0	10	
		Expected	0	0		5.0	5.0		5.0	5.0	
		Chi-square	0	0	0	5.0	5.0	10.5	5.0	5.0	10.5
	No	Observed	100	100		100	90		100	90	
		Expected	0	0		95.0	95.0		95.0	95.0	
		Chi-square	0	0		0.3	0.3		0.3	0.3	
17. Middle to lower 't' crossing	Yes	Observed	0	0		0	6		0	6	
		Expected	0	0		3.0	3.0		3.0	3.0	
		Chi-square	0	0	0	3.0	3.0	6.2	3.0	3.0	6.2
	No	Observed	100	100		100	94		100	94	
		Expected	100	100		97.0	97.0		97.0	97.0	
		Chi-square	0	0		0.1	0.1				
18. Margins left, top right present	Yes	Observed	0	8		0	22		8	22	
		Expected	4.0	4.0		11.0	11.0		15.0	15.0	
		Chi-square	4.0	4.0	8.3	11.0	11.0	24.7	3.3	3.3	7.7
	No	Observed	100	92		100	78		.92	78	
		Expected	96.0	96.0		89.0	89.0		85.0	85.0	
		Chi-square	0.2	0.2		1.4	1.4		0.6	0.6	

Table 2 - (continued)

Character-istics			Andhra Pradesh	Kash-mir	Sum of χ2	Andhra Pradesh	Punjab	Sum of χ2	Kash-mir	Pun-jab	Sum of χ2
19. Margins left and top present	Yes	Observed	17	40		17	44		40	44	
		Expected	28.5	28.5		30.5	30.5		42.0	42.0	
		Chi-square	4.6	4.6	13.0	6.0	6.0	17.2	0.1	0.1	0.3
	No	Observed	83	60		83	56		60	56	
		Expected	71.5	71.5		69.5	69.5		58.0	58.0	
		Chi-square	1.8	1.8		2.6	2.6		0.1	0.1	
20. Margins left and right present	Yes	Observed	60	0		60	0		0	0	
		Expected	38.5	38.5		38.5	21.5		0	0	
		Chi-square	12.1	21.5	54.6	12.1	21.5	54.6	0	0	0
	No	Observed	40	100		40	100		100	100	
		Expected	61.5	34.5		61.5	34.5		100	100	
		Chi-square	7.5	13.5		7.5	13.5		0	0	
21. Margins top and right present	Yes	Observed	0	0		0	6		0	6	
		Expected	0	0		3.0	3.0		0	0	
		Chi-square	0	0	0	3.0	3.0	6.2			6.2
	No	Observed	100	100		100	94		100	94	
		Expected	100	100		97.0	97.0				
		Chi-square	0	0		0.1	0.1				
22. Margins present at top	Yes	Observed	10	21		10	15		21	15	
		Expected	15.5	15.5		12.5	12.5		18.0	18.0	
		Chi-square	2.0	2.0	4.6	0.5	0.5	1.1	0.5	0.5	1.2
	No	Observed	90	79		90	85		79	85	
		Expected	84.5	84.5		87.5	87.5		82.0	82.0	
		Chi-square	0.4	0.4		0.1	0.1		0.1	0.1	
23. Margins present at left	Yes	Observed	2	9		2	3		9	3	
		Expected	5.5	5.5		2.5	2.5		6.0	6.0	
		Chi-square	2.2	2.2	4.7	0.1	0.1	0.7	1.5	1.5	3.2
	No	Observed	98	91		98	97		91	97	
		Expected	94.5	94.5		97.5	97.5		94.0	94.0	
		Chi-square	0.1	0.1		0.0	0.0		0.1	0.1	
24. No margins	Yes	Observed	11	22		11	10		22	10	
		Expected	16.5	16.5		10.5	10.5		16.0	16.0	
		Chi-square	1.8	1.8	4.4	0.0	0.0	0.1	2.3	2.3	
	No	Observed	89	78		89	90		78	90	
		Expected	83.5	83.5		89.5	89.5		84.0	84.0	
		Chi-square	0.4	0.4		0.0	0.0		0.4	0.4	

i. Figure-3 shows 't' written as '+' sign; 'd' written as a circle or semi-circle with straight stem, found to be characteristic in English handwriting of Andhra Pradesh.

ii. Figure-4 shows loop formations on the stem of 'd' and 'h'; loop formations on ending strokes of lower-case 's', found to be characteristic in English hand-writing of Jammu and Kashmir.

iii. Figure-5 shows loop formations on lower and upper parts of the stem of 'f'; 'b' written as numeral '6' and pointed apex of 'A', found to be replaced with rounded top formations in English handwriting of Punjab.

iv. Middle 't' crossing found to be characteristics in English handwriting of Andhra Pradesh and Upper 't' crossing found to be characteristics in English handwriting of Jammu and Kashmir (Figure -4 shows t crossings). However, 't' crossing varied from upper portion to lower portion in English handwriting of subjects from Punjab. (Figure-5 shows 't' crossing variations from upper to lower)

v. Loop formations on the stem of 'k' found to be characteristics in English handwriting of both the states Punjab and Jammu and Kashmir. This may be due to the fact that they are neighbouring states.

English handwritings of subjects from Andhra Pradesh were characterised by leaving the left and right margins, whereas subjects from Punjab left every margin. In the majority of cases, no margins were observed for subjects from Jammu and Kashmir. However, a few of the subjects left the left and top margins.

English handwritings by subjects of Jammu and Kashmir were found to be more artistic with ornamental features as compared to the other two states. The features of incorporation of loop in alphabets 's', 'b', 'h' and 'k' were com-
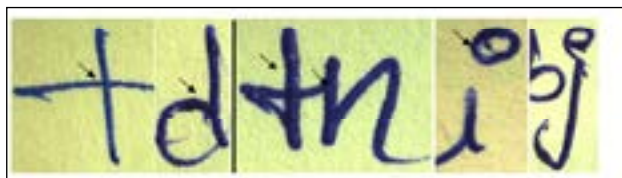

Figure 3- *Significant class characteristics in the handwritings of Andhra Pradesh writers.*

Figure 4- *Significant class characteristics in the handwritings of Kashmir writers.*
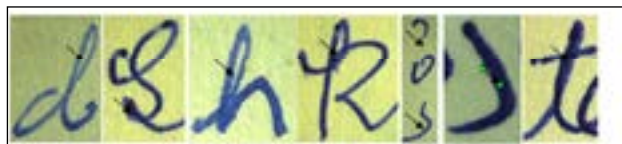

Figure 5- *Significant class characteristics in the handwritings of Andhra Pradesh writers.*

mon. The group used many additional strokes in English writings. Many people were observed to write letter 'j' as the third letter of the Kashmiri script. Figure- 4 shows 'j' written as third letter of Kashmiri script. These observed characteristic features could be due to their favoured hands in writing urdu and kashmiri script.

It was also observed that the dots above 'i' and 'j' were placed towards the right of the body. However, in the handwritings of subjects from Punjab, the placement of the dots 'i' and 'j' varied being vertically above the body in some instances or to the right of the body in others.

Subjects from Andhra Pradesh preferred using tick marks or circle shaped dots 'i' and 'j' . The use of circle-shaped dots was relatively higher in subjects from Andhra Pradesh than in those from other states. This occurrence may be attributed to the possible influence of Telugu script letters 'ah' and 'sa'. Subjects from Andhra Pradesh placed dots above 'i' and 'j' to the left of the body. Moreover, the crossing of the 't' in 'th' was extended to form the staff of

'h' (Figure-3) . This feature was commonly observed in the handwritings of subjects from Andhra Pradesh.

Studies have reported that wide spacing is commonly used after punctuation marks in the handwritings of Tamil, Hindi, and Bengali writers [6,7]. However, in the present study, subjects from Jammu and Kashmir and Punjab had a tendency to leave no space between the letter and punctuation mark. Studies have reported loop formations on the stems of 'd' and the lower part of 's' as a significant class characteristic in Bengali writers. These two characteristics were observed in the handwritings of subjects from Jammu and Kashmir, too. Indian writers, in general, share the common characteristic of a Rounded top formation on 'A'; subjects from Punjab showed higher preference for the rounded top formation on 'A' than subjects from Andhra Pradesh and Jammu and Kashmir, in this study [6,7].

4. Conclusion

The English handwritings of subjects from Andhra Pradesh, Punjab, and Jammu and Kashmir were examined to study whether style characteristics can help determine the nationality/ethnicity of the writer or the state in which the writer learned to write. Characteristic features such as letter formations, punctuation marks, and spacing between letters and margins were observed. The data were analysed using the Chi-Square test to determine significant class characteristics in the English handwritings. The present research had provided a method based on statistics to determine class characteristics in the English handwritings of subjects from three Indian states. Significant class characteristics were identified and their occurrences were attributable to the influence of habitually writing in their own native language, because the impact of regional languages on the subjects' English handwriting was observed in a few

samples. Using this method, document examiners may be able to determine the nationality or ethnic origin of writers. The results of this study may help the forensic document examiners narrow down the search to people from particular states.

Conflict of Interest

No potential conflict of interest reported by the authors.

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