



National characteristics and variation in Arabic handwriting



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ABSTRACT

From each of four Arabic countries; Morocco, Tunisia, Jordan and Oman, 150 participants produced handwriting samples which were examined to assess whether national characteristics were discernible. Ten characters, which have different configurations depending upon their position in the word, along with one short word, were classified into distinguishable forms, and these forms recorded for each handwriting sample. Tests of independence showed that character forms used were not independent of country ($p < 0.001$) for all but one character-position (this was dropped from subsequent analyses). A correspondence analysis ordination plot and analysis of similarity ($R = 0.326$, $p = 0.0002$) showed that whole samples were discernibly grouped by country, and a tree analysis produced a classification which was 71% accurate for the original data and 83% accurate for 80 new handwriting samples that underwent 'blind' classification. When the countries were combined into two regions, North Africa and Middle East, the grouping was more marked. Thus, there appears to be some scope for narrowing down the nationality, and particularly the wider geographical region of an author based upon the character forms they use in Arabic handwriting.

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1. Introduction

Forensic handwriting experts view the static image of handwriting and rarely have the opportunity to directly access the detailed dynamics of the handwriting process by obtaining data from handwriting tablets that provide data about pen movement. For this reason, forensic examiners use subjective methods of examination when making their assessment of a piece of handwriting [1].

Handwriting is a complex skill that requires the integration of both cognitive and motor skills [2,3]. This complexity is apparent at two inter-related levels. The general features used by a person in their handwriting, often called class characteristics, are influenced by the style that is taught and acquired typically during the earlier stages of childhood [4]. Individual characteristics are those that are developed by writers themselves as their handwriting style changes in later years [1].

The style taught formally will vary by location and time [5]. Different countries, for example, may use different educational materials upon which to base the teaching of handwriting [6]. One

of the main teaching resources is the 'copybook' which describes ways in which handwriting can be produced including the method of construction and its shape and appearance and the copybooks are likely to vary from place to place [7]. Different copybook styles are likely to be reflected by different class characteristics of the people taught using them and hence the possibility of national characteristics in handwriting features.

National characteristics have been studied in a number of places. Turnbull et al. [8] found class characteristics that to a greater or lesser extent were found to occur more in those with a Polish background compared to those with an English background. On a slightly different theme, Muehlberger [5] found a number of features that were more frequently encountered in the handwriting of Hispanic people within the south east of the USA. Similarly, Cheng et al. [9] found that writers from different racial groups (Chinese, Malay and Indian) in Singapore used a number of different class characteristics.

Studies of national handwriting traits have focussed mainly on the Roman script. Arabic ranks as the sixth language of the world in terms of numbers of native speakers and it is the national and official language in 21 Arab States [10]—Fig. 1. These states stretch from North Africa in the West to the Sultanate of Oman in the East and from Sudan in the South to Syria in the North [11]. A decade ago, literacy rates of Arabic ranged from 40% (Mauritania) to 90% (Jordan) and were increasing [12]. Arabic script is cursive, being

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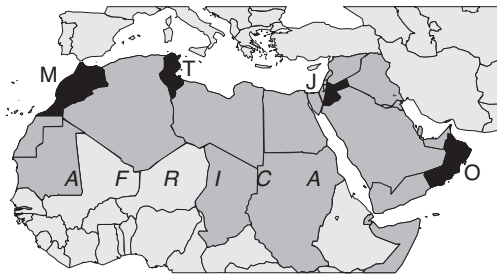


Fig. 1. Location of the countries where samples were collected (in black; M—Morocco, T—Tunisia, J—Jordan, O—Oman). Additional countries with Arabic as an official language are shown in darker grey.

written from right to left and the character forms depend upon whether it is connected as the start, middle or end of a word, or disconnected [13].

Modern Standard Arabic (MSA) is the official means of communication throughout all Arab states. Considerable variation of MSA in handwriting, however, does occur. Arabic characters have different forms according to their position in a word and as it is constructed cursively, there is variation in how characters connect to those preceding or following. The shape, size and relative position of glottal dots (for example *?*, *?*, and *?*) are another source of variation particularly associated with Arabic [14].

In view of the extensive use of written Arabic across a large geographical area, there is a possibility that differing cultural, and particularly educational, factors from one country to another will be apparent in the handwriting from people of different Arab countries. Indeed as handwriting class features gradually change as one moves from one country to another there may be regional variations across the Arab world. This aspect of change across a geographical area has not been studied in detail before.

The primary purpose of this study, therefore, was to determine whether or not Arabic handwriting written in different countries shows class characteristics that indicate the writer's nationality and background, as has been found in studies of Roman script (e.g. [8,9]), or perhaps region. If this were possible, it would have value in a forensic context by potentially providing intelligence about the writer based upon a handwriting sample. A straightforward and efficient way of assessing any potential national or regional characteristics from the static image was required. For this reason, a subjective method of feature extraction was used in this study (as also used for example by Cheng [9]).

2. Methods

From each of four Arabic countries; Morocco, Tunisia, Jordan and Oman (west to east as shown in Fig. 1), 150 participants produced Arabic handwriting samples via a questionnaire which required the writing of particular standard passages. An individual in each country managed the collection of samples to capture demographic and geographic variation in adult native residents in line with ethical processes of the University of Central Lancashire and Royal Oman Police. Countries were chosen based upon where agents were available and the collection of samples seemed feasible, in addition to the desire to include geographic variation.

The choice of participants for obtaining the samples for the analysis was based primarily on two factors, the first being that they be in the age group of eighteen to about seventy and the second factor being that they have attained a sufficient level of basic education. Otherwise, the selection of participants was random from a number of different places to avoid any local effects that might skew the sample.

An even balance of male and female participants was achieved in all countries except Morocco where six more males than females took part. The written passages contained all alphabetic characters in positions unconnected (free), and at the start, middle and end of a word (denoted F, S, M and E, respectively), all written on ruled A4 white paper. Information on each participant's age, gender, handedness and education level was also recorded (Table 1).

Samples were scanned and stored digitally allowing enlargement to visually discern finer detail. In order to analyse handwriting characteristics shared by large numbers of people, it was first necessary to consider what kinds of feature could be analysed. This can only be done manually by a process of feature extraction which involves examining some of the samples of handwriting looking for patterns of feature use that seem to differ between people from different countries. Ten characters were thus chosen to represent diversity in structure, and one short word made of two characters (Lam-Alif). The characters have different configurations depending upon their position in a word, which meant a total of 37 characters/forms were examined. Distinguishable forms of these characters were then identified (Table 2) as all handwriting samples were analysed by the same investigator. The character form used in each handwriting sample was recorded for each of the characters/positions.

For four of the characters (Jeem, Thaa, Ghayn and Kaf) chosen arbitrarily, a second investigator, a non-Arabic speaking individual,

Table 1
Demographic data as frequencies and percentages of the 150 participants from each country.

Variable	Category	Morocco		Tunisia		Jordan		Oman		Overall	
		No	%	No	%	No	%	No	%	No	%
Age	Under 20	18	12.0	9	6.0	18	12.0	4	2.7	49	8.2
	20–29	78	52.0	77	51.3	81	54.0	90	60.0	326	54.3
	30–39	24	16.0	47	31.3	28	18.7	40	26.7	139	23.2
	40–49	21	14.0	8	5.3	16	10.7	10	6.7	55	9.2
	50–59	8	5.3	8	5.3	7	4.7	4	2.7	27	4.5
	60–69	1	0.7	1	0.7	0	0.0	2	1.3	4	0.7
Gender	Female	72	48.0	75	50.0	75	50.0	75	50.0	297	49.5
	Male	78	52.0	75	50.0	75	50.0	75	50.0	303	50.5
Education	Preparatory	9	6.0	14	9.3	11	7.3	7	4.7	41	6.8
	Secondary	88	58.7	46	30.7	40	26.7	43	28.7	217	36.2
	Diploma	10	6.7	2	1.3	36	24.0	23	15.3	71	11.8
	Further	39	26.0	85	56.7	60	40.0	75	50.0	259	43.2
	Without	4	2.7	3	2.0	3	2.0	2	1.3	12	2
Handedness	Both	6	4.0	2	1.3	2	1.3	1	0.7	11	1.8
	Left	5	3.3	17	11.3	10	6.7	13	8.7	45	7.5
	Right	139	92.7	131	87.3	138	92.0	136	90.7	544	90.7

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