

Survey of Handwriting Habit Areas Used by Forensic Document Examiners: Degree of Use and Discriminatory Power

Richard C. Hanlen

National Security Division, Pacific Northwest National Laboratory, P. O. Box 999, Richland, WA 99352-0999

Patricia A. Manzillo, Robert J. Muehlberger, and Grant R. Sperry

U.S. Postal Inspection Service/Forensic Laboratory, 225 N. Humphreys Blvd., Memphis, TN 38161-0003

In April 1998, a survey was distributed to Forensic Document Examiners (FDEs) requesting an evaluation of the habit areas used and their utility in distinguishing handwriting. The information obtained from this survey was intended to provide the data necessary to select a preliminary set of characteristics for analysis. It is important to use these relative rankings as an indication of general tendency and possible discriminatory dominance as compared to an absolute ranking of discriminatory dominance over the other habit areas. The particular circumstances surrounding the examination of handwriting can dictate a far different ordering of habit areas.

Introduction

Beginning in 1998, the Pacific Northwest National Laboratory, U.S. Postal Inspection Service/Forensic Laboratory, and the Data Fusion Laboratory, Drexel University have been collaborating on a large-scale research project, "Handwriting Individuality - Moving From Art to Science." In April 1998, a survey was distributed to the community of Forensic Document Examiners (FDEs) requesting input on the habit areas used and their utility in distinguishing handwriting. The information obtained from this survey was intended to provide the data necessary to select the criteria and begin the evaluation of the handwriting samples currently in the project. Preliminary results of the survey were made available to the community at the American Society of Questioned Document Examiners (ASQDE) meeting in August 1998 and the American Academy of Forensic Sciences (AAFS) meeting in February 1999. This article provides documentation of the survey and its results.

This survey had two objectives: 1) to compile a list of handwriting features and characteristics

used by professional FDEs in the examination and comparison of handwriting and 2) to gather information about the significance of these features and characteristics. These objectives were met by having the FDEs provide an indication of their experience in the frequency of habit area evaluation and the utility of the habit area for discrimination.

FDEs, through a combination of training and experience, identify the important characteristics of a writing sample, conduct comparative examinations of habit agreement/disagreement, and assess the significance of the comparison. Some commonly compared characteristics include size, slant, line quality, letter formation, height relationships of letter forms, and writing pressure. Examinations are conducted and conclusions are derived primarily from experience and training. Although there has been minimal empirical validation to support the premises or methodology, there have been several recent studies that establish the proficiency of trained FDEs versus lay people.

A person's handwriting style is the result of a continuous process that starts in grade school

with the imitation of penmanship models, and develops into a refined set of complex habitual motor skills. Handwriting habits are acquired and developed over a period of time and are influenced by a number of factors such as perception, coordination, dexterity, muscle development, writing systems studied, family associations, occupation, education, and cultural influences. These factors assert themselves through class and individual handwriting characteristics, which cumulatively compose an individual's writing habits. It is the manifestation of these habits that enables handwriting identification.

Two fundamental assumptions provide the foundation for any handwriting examination: (1) an individual has an identifiable set of handwriting characteristics (i.e., habits) appearing consistently throughout his or her natural writing, and (2) the combination of handwriting characteristics for an individual is unique. From these two assumptions, it follows that any natural writing may be associated with its author, provided the writing contains sufficient individual habit features, and provided a fully comparable known writing sample is available. FDEs have accepted these concepts because they are reasonable and observable rather than through rigorous scientific validation. Reliable handwriting identification capabilities have traditionally been achieved through FDE training and experience. The results of this survey are intended to generate a set of handwriting characteristics that could be used in future research and statistical analysis of handwriting identification methodologies.

Methods and Materials

The survey was administered over the Internet and through email. A full copy of the transmitted survey and responses is included in the technical report (Hanlen, Manzolillo, Muehlberger, and Sperry, 1999). Preliminary results of the survey were made available to the community at the ASQDE meeting in August 1998 and the AAFS meeting in February 1999.

The survey recipients were instructed to formulate their responses in the context of evaluating the handwriting of a particular writer. The characteristics of the body of writing evaluated include: 1) cursively written, 2) representative of the writer's natural handwriting, 3) original (not a photocopy) written in ballpoint ink, and 4) of sufficient quantity for a complete evaluation.

These instructions were provided to the survey participants to establish a common starting point for the survey assessments.

Based upon a review of the existing literature (Osborn, 1929, 1944; Harrison, 1966; Hilton, 1982; and Conway, 1959), thirty-four possible handwriting habit areas were selected for the survey. A few of these habit areas (i.e., gender and personality) were included to gauge the responsiveness of the survey participants. The survey also provided the participants with the opportunity to include additional habit areas they would consider in a handwriting examination. Some definitions were provided to specifically ensure clarity.

Alignment: relationship of parts of characters, entire characters, words or lines of writing to a baseline (actual or perceived)

Rhythm: regularity in size, slant and curvature of the writing line

Penmanship: the ability to adhere to a writing system (i.e. Palmer, Zaner-Bloser)

Hesitation: a temporary halt in the writing movement with no break in the writing line

Relative Size/Slant Spacing: relationship of parts of characters, entire characters, words or lines of writing to each other

Idiosyncrasies: anything odd or peculiar in an individual's handwriting

There were two inter-related questions asked of the survey recipients for each of thirty-four habit areas. The first question was: "How often do you evaluate a particular habit area (e.g., letter formations)?" Possible responses included:

- One *always* evaluates letter formations (denoted by an "A"),
- One *never* evaluates letter formations (denoted by an "N"), and
- One *sometimes* evaluates letter formations (denoted by an "S").

The second question on the survey drew upon the experience and training of the survey recipient regarding the observed discriminatory power of specific habit areas. "With respect to a particular habit area (e.g., letter formations), have you found features or characteristics to be of high (H), medium (M) or low (L) significance?" Possible responses include:

ABFDE Certified			
Years Experience	Yes	No	Total
0 - 3	0	10	10
4 - 10	4	6	10
11 - 20	13	12	25
21+	24	4	28
Total	41	32	73

Table 1: Demographics of Survey Respondents

- If features and characteristics associated with “letter formations” frequently contribute to the discrimination of one writer’s habits from another’s, an “H” (for high) was written in the significance column.
- If features and characteristics associated with “letter formations” occasionally contribute to the discrimination of one writer’s habits from another’s, an “M” (for medium) was written in the significance column.
- If features and characteristics associated with “letter formations” rarely contribute to the discrimination of one writer’s habits from another’s, an “L” (for low) was written in the significance column.

The technical report (Hanlen, Manzollilo, Muchlberger, and Sperry, 1999) provides the “as-transmitted” survey, the survey “raw” data, and a table of results. This report also provides an overview of the survey, gives a demographic display of the respondents, and provides a brief discussion of the results of the survey. For convenience, only the table of results is provided in this article.

Results and Discussion

The survey was sent to one hundred-forty Forensic Document Examiners. Of these, seventy-three provided a response. The specific demographics (years experience and certification) are displayed in Table 1. Two of the seventy-three had no direct responses to the thirty-four descriptions of handwriting habit areas. Forty-one respondents

are American Board of Forensic Document Examiners (ABFDE) certified. Ten of the seventy-three respondents have less than three years experience. Fifty-three respondents have more than ten years experience; of these, twenty-eight had more than twenty years experience. Twenty-eight respondents provided additional detailed comments. Note that in the ensuing summary (Table 3 and Table 4), only seventy-one responses are recorded. The seventy-one total results from two people who provided demographic input, but chose not to respond to the discriminatory use of habit areas (one with 11-20 years experience and no certification, one with more than 21 years experience and certification).

Net-Effectiveness Score

A net-effectiveness score was developed that contrasts high discriminatory value and *always used* ratings with *never used* or low discriminatory power. Each of the thirty-four survey characteristics was tallied across FDE response by degree of use and discriminatory power, as shown in Table 2. The survey was evaluated in terms of ranking the difference between the number of positive responses (denoted #1 in Table 2 — *always use* the characteristic and the characteristic has high or medium discriminatory power) and negative responses (denoted #2 in Table 2 — *sometimes use* and low discriminatory power or *never use* and low discriminatory power or blank).

An illustration of the tabulation of the seventy-one survey responses for the Slant - Relative Between Words habit area is shown in Table 3. Forty-three survey respondents indicated that they always look at slant relative between words, and

Discriminatory Power				
Degree of Use	High	Medium	Low	Blank
Always	#1			
Sometimes			#2	
Never				

Table 2. Illustration of Summary Table for 1 of 34 Characteristics from Survey

they also find that it has high discriminatory power. Two of the respondents indicated that they sometimes use this habit area and find its discriminatory power to be low. The numeric value assigned to the net-effectiveness score for Slant - Relative Between Words is 55 (forty-three plus fourteen minus two). A full table of net-effectiveness scores and relative ranks for each of the thirty-four habit areas is provided in Table 4. Relative rankings are provided for various years of experience and for the overall set of respondents as indicated in the column headings. The overall rankings are derived from sorting the net-effectiveness score and breaking ties by the relative position in the survey. The years of experience ranking is obtained by sorting by net-effectiveness score for the specified years category and breaking ties by use of the overall ranking.

The “top-eleven” characteristics (as characterized by all seventy-one respondents) cited as generally of high discriminatory value and *always used* versus *never used* or low discriminatory power are provided below. More than 94% of the survey respondents cited these as *always used* and medium to high discriminatory power.

- Letter Design/Formation
- Connecting Strokes

- Beginning/Ending Strokes
- Line Quality
- Writing Skill
- Hesitation
- Pen Lifts/Disconnects
- Variation
- Size - Relative Within Character
- Size - Relative Between Character
- Spacing - Relative Between Character

The characteristic Speed demonstrated the greatest difference between ABFDE-certified and non-certified respondents. ABFDE non-certified respondents ranked Speed higher as an effective characteristic for evaluation. It is interesting to note that those with 21+ years experience in the field felt strongly that Rhythm should be included as a top-eleven item (relative rank of 8 out of 34) when overall it ranked number 20. A possible explanation may be a difference in usage of terminology between generations of document examiners (i.e., for those examiners with less than 21 years of experience, Rhythm may be included with Line Quality). Overall, there was little difference among the ranking of the top eleven characteristics.

The bottom thirteen of the thirty-four characteristics in terms of discriminatory value and us-

Discriminatory Power				
Degree of Use	High	Medium	Low	Blank
Always	43	14	4	
Sometimes	1	7	2	
Never				

Table 3. Illustration of Summary Table for Slant - Relative Between Words from Survey

Habit Area	Net-Effectiveness Score					Ranking				
	Overall	0-3 Years	4-10 Years	11-20 Years	21+ Years	Overall Sort	0-3 Year Sort	4-10 Years Sort	11-20 Years Sort	21+ Years Sort
Pen lifts/Disconnects	71	10	10	24	27	1	1	1	1	1
Letter Design/Formation	70	9	10	24	27	2	13	4	3	3
Connecting Strokes	70	9	10	24	27	3	14	5	4	4
Line Quality	70	10	10	24	26	4	2	2	2	6
Size - Relative: within Character	70	10	10	23	27	5	3	3	6	2
Hesitation	69	9	10	23	27	6	15	8	8	5
Variation	69	10	10	24	25	7	4	6	5	9
Size - Relative: between Characters	69	10	10	23	26	8	5	7	7	7
Spacing - Relative: between Characters	68	10	10	23	25	9	6	9	9	10
Beginning/Ending Strokes	67	10	10	22	25	10	7	10	13	11
Writing Skill	67	9	10	23	25	11	16	11	10	12
Angularity/Roundness	66	9	10	22	25	12	17	13	15	14
Alignment/Baseline	66	10	10	22	24	13	8	12	14	17
Retouching/Added Strokes	66	9	9	23	25	14	18	21	11	13
Idiosyncrasies	65	10	8	22	25	15	9	25	16	15
Pressure Variation	64	9	10	21	24	16	19	14	17	18
Speed	64	9	10	23	22	17	20	15	12	19
Slant - Relative: between Characters	64	10	9	20	25	18	10	22	20	16
Spacing - Relative: between Words	63	10	10	21	22	19	11	16	18	20
Rhythm	62	9	10	17	26	20	21	18	26	8
Size - Relative: between Words	62	10	10	20	22	21	12	17	21	21
Flourishes/Embellishments	56	8	9	18	21	22	23	23	23	22
Slant - Relative: between Words	55	8	9	17	21	23	24	24	27	23
Spacing - Absolute/Overall	55	9	10	20	15	24	22	19	22	30
Spacing - Relative: between Lines	55	8	10	18	19	25	25	20	24	25
Diacritics	55	7	7	21	20	26	27	29	19	24
Slant - Relative: between Lines	49	8	8	16	17	27	26	26	29	26
Arrangement/Format - Punctuation	47	6	6	18	17	28	30	30	25	27
Size - Absolute/Overall	46	6	8	16	16	29	31	27	30	28
Arrangement/Format - Margins	45	7	6	16	16	30	28	31	31	29
Slant - Absolute/Overall	44	7	8	17	12	31	29	28	28	31
Penmanship	7	1	-6	2	10	32	32	32	32	32
Personality	-62	-10	-8	-22	-22	33	34	33	33	33
Gender	-64	-9	-10	-22	-23	34	33	34	34	34

Table 4: Full Table of Net-Effectiveness Ratings and Relative Ranks

age are provided below. All of the mentioned characteristics except one cited below had at least one respondent cite them as low discriminatory power, *sometimes* or *never*. The one exception was Spacing – Relative Between Lines which did not receive enough responses in the *always used* and high or medium discriminatory power.

- Flourishes/Embellishments
- Arrangement/Format – Margins
- Arrangement/Format – Punctuation
- Gender
- Penmanship
- Size – Absolute/Overall
- Slant – Absolute/Overall
- Slant – Relative Between Words
- Slant – Relative Between Lines
- Spacing – Absolute/Overall
- Spacing – Relative Between Lines
- Personality
- Diacritics

There are no appreciable differences to note in the bottom thirteen characteristics by experience or by certification.

The most common additional habit areas to add to the thirty-four are listed below. These are listed in the order of the frequency they were cited (most frequent to least) by the respondents.

- Spelling
- Abbreviations
- Mixed usage upper/lower case
- Handedness
- Age
- Numerals
- Mixed usage hand printing vs. handwriting

Other listed habit areas addressed conditions specifically excluded by the assumptions specified in the survey. These included unnaturalness, evidence of disguise, writing instrument, or writing conditions.

Some survey recipients expressed that it was difficult to assign frequency of habit area evaluation (always (A), sometimes (S), or never (N)) and the frequency in which habit areas/features contribute to the discrimination of one writer's habits from another's (frequently contribute — high (H), occasionally contribute — medium (M), and rarely contribute — low (L)). It is important therefore to use these relative rankings as an indication of general tendency and possible discriminatory dominance as compared to an absolute rank-

ing of discriminatory dominance over the other habit areas. The particular circumstances surrounding a specific handwriting examination can dictate a far different ordering of habit areas.

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