

**Survey of Forensic Document Examination Habit Areas:
Degree of Use and Discriminatory Power**

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The work reported on here is part of a collaborative effort between staff at the United States Postal Inspection Service (USPIS) Forensic Laboratory, Memphis, Tennessee; Drexel University Data Fusion Laboratory (DFL), Philadelphia, Pennsylvania; and Pacific Northwest National Laboratory (PNNL), Richland, Washington. The authors also acknowledge the support of the FDE's for their participation in this survey.

1.0 Introduction

Beginning in 1998, the Pacific Northwest National Laboratory (PNL), US Postal Inspection Service Forensic Laboratory (USPIS), and the Data Fusion Laboratory, Drexel University (DFL) 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 report provides final documentation of the survey and its results.

This survey has two objectives: 1) to compile a list of handwriting features and characteristics used by professional forensic document examiners in the examination and comparison of handwriting and 2) to gather information about the significance of these features and characteristics. These objectives are 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 from experience and training with little empirical validation to support the premises or methodology. The scientific reliability of handwriting identification must be established through empirical validation of the premises and standardization of methodology. The few studies (cited by Risinger et. al. (1989) and provided in the references here under published reports and studies) that have approached the problem are deficient in many different areas: 1) studies are based on subjective or non-quantitative evaluations and classifications, 2) the experimental methodology lacks validation, 3) results are limited to observations and descriptions, and do not include statistical analysis, 4) analysis is limited to a few characteristics and habit areas, 5) a limited number of samples are used, 6) a lack of uniformity in samples limits cross comparability and analysis, and 7) publications and peer reviewed methods and results are lacking.

The scientific basis for handwriting individuality and the expertise of handwriting examiners has been questioned in several court cases and law review articles (see the court cases and law reviews cited in the references). The criticisms were originally directed at the proficiency and expertise of forensic document examiners (FDE's). However, these criticisms also illustrate the lack of empirical data to support and validate the premises and methodology of handwriting examination. As a result, the admissibility

and weight of FDE testimony has been called into question. These assaults on the scientific integrity of handwriting analysis have created an urgent need for the forensic document examination community to develop objective standards, measurable criteria, and a uniform methodology supported by properly controlled studies that evaluate and validate the significance of measurable handwriting characteristics. There has been recent effort to establish the proficiency of trained FDE's versus lay people (Kam et. al. , 1994, 1997, and 1998).

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: perception, coordination, dexterity, muscle development, writing systems studied, family associations, occupation, education, 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 scientific validation. Reliable handwriting identification capabilities have traditionally been achieved through FDE training and experience and not objective statistical analysis.

The planned steps in this project for validation of the basis for handwriting examination are:

- 1) conduct a survey of the habit areas used by the community and obtain a sense of the general discriminatory power of each habit area,
- 2) quantify a subset of the features associated with the principle discriminatory habit areas,
- 3) establish the features and construct a profile for an individual and
- 4) determine the degree of individuality of each handwriting profile. The survey described in this report is intended to satisfy the first of these steps.

Section 2 provides an overview of the Survey and gives a demographic display of the respondents. Section 3 provides a brief discussion of the results of the survey. The attachments provide the "as-transmitted survey, the survey "raw" data, and a table of results.

2.0 Discussion of Survey

The survey was administered over the internet and through email. A full copy of the transmitted survey is included in Appendix A. The responses were tabulated by USPIS and are provided in Appendix B. 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 couch their responses in context of evaluating the handwriting of a particular writer. The characteristics of the body of writing evaluated include: 1) cursive 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.

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 of 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?" 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 survey was sent out to one hundred forty forensic document examiners. Of these, seventy-three provided a response. The specific demographics (age 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 (Section 3) and Appendix C, only seventy-one responses are recorded. The seventy-one total results from two people that 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).

Table 1: ABFDE Certification for Years Experience.

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

3.0 Survey Results

A net effectiveness ranking metric 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 were 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 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 no comment provided).

Table 2: Illustration of Summary Table for one of 34 Characteristics from Survey.

<u>Degree of Use</u>	<u>Discriminatory Power</u>			
	High	Medium	Low	Blank
Always	# 1			
Sometimes			#2	
Never				

An illustration of the tabulation of the seventy-one survey responses for the slant – relative-between-words habit area is shown below. Forty-three survey respondents indicated that they always look at slant relative between words and 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 rating for slant relative between words is 55 (forty-three plus fourteen minus two).

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

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

A full table of net effectiveness ratings and relative ranks for each of the thirty-four habit areas is provided in Appendix C. Relative rankings are provided for various years of experience as indicated in the column headings.

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.

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 useage 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). There was generally not too much difference between the top eleven. Those that do not claim ABFDE certification status cited speed as an effective characteristic for evaluation.

The "bottom-thirteen" of the thirty-four characteristics in terms of discriminatory value and usage are provided below. All of the mentioned characteristics except one cited below had at least one respondent cite them as low, sometimes or never. The one exception was spacing – relative between lines which did not receive enough "positive" support in the #1 category.

- 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 up/lower case
- Handedness
- Age
- Numerals
- Mixed usage hand printing vs. handwriting

Other listed habit areas addressed conditions specifically excluded by the scenario such as: unnaturalness, evidence of disguise, writing instrument, or writing conditions. These writing conditions are not considered by the assumptions specified by the survey.

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 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.

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APPENDIX A

Survey "As-Transmitted"

Appendix A: Survey "As-Transmitted"

Subject: Important FDE Survey re: Individuality of Handwriting

Dear Forensic Document Examiners and Colleagues:

Your assistance in completing the following survey represents a significant contribution to this project and would be greatly appreciated. Information, instructions, and points of contact are provided below. (We're utilizing two e-mail lists for distribution, so we apologize if you get this twice)

You are encouraged to make copies or send this survey to other FDE who may not have received this e-mailing; or e-mail me (webeditor@asqde.org) with their e-mail address or mailing address and we will send them the survey.

Please complete and return this survey by April 12, 1998.

Upon completion of the survey, return it by any of the means listed below:

- 1) e-mail to: webeditor@asqde.org
- 2) fax to: Patricia Manzolillo or Grant Sperry @ 901-747-7778
- 3) mail to: US Postal Forensic Lab
Attn: P.A. Manzolillo
225 N. Humphreys Blvd. 4th Flr
Memphis, TN 38161-0003

Thanks again for your contribution!

Grant R. Sperry
Webeditor, ASQDE

I. Introduction

This survey has two goals: 1) to compile a list of handwriting features and characteristics used by professional forensic document examiners in the examination and comparison of handwriting and 2) to gather information about the significance of these features and characteristics.

The survey is the first step in the large scale research project "Handwriting Individuality - Moving From Art to Science" being conducted by Pacific Northwest National Laboratory, WA, US Postal Inspection Service Forensic Laboratory, Memphis, TN and Data Fusion Laboratory, Drexel University, Philadelphia, PA. During the first year of the project it is expected that the underlying scientific and statistical support for the axioms of handwriting individuality will be established. The information gathered by this survey will provide the data necessary to select the criteria and begin the evaluation of the handwriting samples currently in the project. In addition, the results of this survey will assist the standardization efforts of TWGDOC and will be made available to the forensic document committee.

The results of this survey will be sent to all participants as soon as the data is tabulated (within a month after surveys are returned). The biographical data will be used solely as background demographic information of the examiners who participate in the survey.

Please complete the entire survey, a task that can reasonably be accomplished in 20 minutes. The contribution of your time and expertise to this project is greatly appreciated.

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II. Biographical

Name:

Mailing Address:

Email:

Employment related to document examination:

Basic training:

years: Laboratory/Institution:

Primary Instructors:

Post-Basic Training:

Total # years: # years govt: # years private:

Education: (university, field of study, degree)

Undergraduate:

Graduate:

Continuing Education related to document examination:

Date of last continuing education course attended:

Date of last conference attended:

Certification: ABFDE (yes /no)

Other: (please list)

Professional Organizations and Affiliations:

(Mark all that apply.)

ASQDE

MAFS

IAFS

AAFS

MAAFS

ASFDE

SAFDE

NEAFS

GFS

SWAFDE

CSFS

Other:

III. Survey of Handwriting Characteristics

For purposes of completing this survey, assume the following hypothetical information. You are evaluating the handwriting of a particular writer. The body of writing is: 1) cursively written, 2) representative of the writer's natural handwriting, 3) an original (not a photocopy) written in ball point ink, and 4) of sufficient quantity for a complete evaluation

There are two inter-related questions in this survey. The first question is: "How often do you evaluate a particular habit area (e.g. letter formations)?" If you always evaluate letter formations, write an "A" in the Evaluation column. If you never evaluate letter formations, write an "N" in the Evaluation column. If your answer is somewhere between always and never, write an "S" (sometimes) in the Evaluation column.

The second and more important question of the survey draws upon experience and training. "With respect to a particular habit area (e.g. letter formations), have you found features or characteristics to be of high, medium or low significance?" If features and characteristics associated with "letter formations" frequently contribute to the discrimination of one writer's habits from another's, write an "H" (for high) 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, write an "M" (for medium) 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, write an "L" (for low) in the Significance column.

The terms used in the following section were collected from a variety of sources, for which references are provided. We have also provided some definitions, but feel free to contact us for clarification of any part of the survey. Please add any other habit areas/terms we have not specified on the main section by writing them in the space provided. These answers will provide crucial data, so please give serious consideration to your answers. Examiners with all levels of experience and training are encouraged to reply. Since all answers will be based upon individual experience and training there are no "right" or "wrong" answers.

(Definitions below are provided for purposes of this survey)

- 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

Using the directions, examples and definitions above, please complete the section below.

Habit Area/Feature	Evaluation (A/S/N)	Significance (H/M/L)
1. Letter Design/Formation		
2. Connecting Strokes		
3. Angularity/Roundness		
4. Beginning/Ending Strokes		
5. Flourishes/Embellishments		
6. Alignment/Baseline		
7. Arrangement/Format: Margins		
8. Arrangement/Format: Punctuation		
9. Line quality		
10. Rhythm		
11. Pressure Variation		
12. Speed		
13. Writing Skill		
14. Gender		
15. Penmanship		
16. Hesitations		
17. Pen Lifts/ Disconnects		
18. Variation		
19. Size: Absolute/Overall		
20. Size: Relative: within characters		
21. Size: Relative: between characters		
22. Size: Relative: between words		
23. Slant: Absolute/Overall		
24. Slant: Relative: between characters		
25. Slant: Relative: between words		
26. Slant: Relative: between lines		
27. Spacing: Absolute/Overall		
28. Spacing: Relative: between characters		
29. Spacing: Relative: between words		
30. Spacing: Relative: between lines		
31. Personality		
32. Retouching/Added Strokes		
33. Diacritics		
34. Idiosyncrasies		

Below, list any additional habit areas or features you utilize during examinations which were not included in the list above. Apply the same evaluation criteria as you did previously.

Habit Area/Features	Evaluation (A/S/N)	Significance (H/M/L)
---------------------	--------------------	----------------------

Comments:

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APPENDIX B

Detailed Survey Data

Table B1: D

Id#	Post-Basic Training		FDE Certified ABFDE (Yes/No)?	Letter Design/Formation Evaluation Significance		Con Evaluati
	# Years	# Govt.				
1	15	15	YES	A	H	A
2	19	19	NO	A	H	A
3	22	13	NO	A	H	A
4	3.5	3.5	NO	A	H	A
5	28	28	YES	A	H	A
6	12	12	NO	A	M	A
7	31	25	YES	A	H	A
8	17.5	16	NO	A	M	A
9	11	11	YES	A	H	A
10	14	14	NO	A	H	A
11	17	17	YES	A	H	A
12	13	7	YES	A	H	A
13	13	13	NO	A	H	A
14	22	22	YES	A	H	A
15	22.5	22.5	YES	A	H	A
16	24	24	YES	A	H	A
17	43	43	YES	A	H	A
18	24	24	YES	A	H	A
19	37	34	YES	A	M	A
20	8	8	NO	A	H	A
21	8	4	YES	A	H	A
22	15	15	YES	A	H	A
23	23	23	YES	A	H	A
24	31	31	YES	A	M	A
25	3.5	3.5	NO	A	H	A
26	23	13	NO	A	H	A
27	15	0	YES	A	H	A
28	22	9	NO	A	H	A
29	25	24	YES	A	H	A
30	0	0	NO	A	M	A
31	27	27	YES	A	H	A
32	44	0	YES	A	H	A
33	1	1	NO	A	H	A
34	9	1	YES	A	H	A
35	23	23	YES	A	H	A
36	0	0	NO	A	M	A
37	0	0	NO	A	M	A
38	5	5	NO	A	H	A
39	8.5	8.5	NO	A	H	A
40	20	10	YES	A	H	A
41	22	22	YES	A	H	A
42	18	7.5	YES	A	H	A
43	14	14	NO	A	H	A
44	9	9	NO	A	H	A
45	25	21	YES	A	H	A
46	27	9	YES	A	H	A
47	20	20	YES	A	H	A
48	15	15	YES	A	H	A
49	2	1	NO	A	H	A
50	30	30	YES	A	H	A
51	12.5	12.5	NO	A	H	A
52	17.5	17.5	YES	A	H	A
53	7	7	YES	A	H	A
54	19	19	YES	A	H	A
55	21	21	YES	A	H	A
56	32	32	YES	A	H	A
57	16	16	NO	A	H	A
58	5	5	YES	A	H	A
59	2	2	NO	A	H	A
60	34	34	YES	A	H	A
61	24	24	YES	A	H	A
62	1	1	NO	A	H	A
63	49	26	YES			
64	20	20	NO	A	H	A
65	22	22	NO	A	H	A
66	17	0	NO	A	H	A
67	18	6	YES	A	H	A
68	8	8	NO	A	H	A
69	6	6	NO	A	H	A
70	31	7	YES	A	H	A
71	19	3	NO			
72	17	17	NO	A	M	A
73	0	0	NO	A	L	A

Table B1

Id#	Alignment/Baseline		Arrangement/Format - Margins		Arrangement/Format - Punct	
	Evaluation	Significance	Evaluation	Significance	Evaluation	Significance
1	A	H	A	M	A	M
2	A	H	A	H	A	M
3	S	M	S	M	S	M
4	A	M	A	L	A	M
5	A	H	A	M	A	M
6	A	M	A	M	A	M
7	A	L	A	M	A	M
8	A	M	S	M	A	H
9	A	H	S	L	S	L
10	A	L	A	M	A	M
11	A	M	A	M	A	M
12	A	M	A	M	A	M
13	A	H	A	H	A	H
14	A	M	S	M	S	M
15	A	H	A	M	A	M
16	A	M	A	L	A	L
17	A	M	A	M	A	H
18	A	M	S	M	S	M
19	A	M	A	M	A	M
20	A	H	A	M	A	M
21	A	H	A	H	A	M
22	A	M	S	M	S	M
23	A	H	A	H	A	H
24	A	H	A	M	A	M
25	A	M	A	M	A	M
26	A	H	S	M	S	M
27	A	M	A	M	A	M
28	A	H	A	L	A	M
29	A	H	A	M	A	M
30	A	M	A	L	A	L
31	A	H	S	M	S	M
32	S	M	S	M	A	M
33	A	H	A	M	A	M
34	A	M	A	M	S	M
35	A	H	A	H	A	M
36	A	H	A	M	A	M
37	A	H	S	M	S	M
38	A	M	A	M	A	M
39	A	H	A	M	A	M
40	A	H	A	H	A	M
41	A	H	A	M	S	M
42	A	H	S	M	S	M
43	A	M	A	M	A	H
44	A	M	A	M	A	M
45	A	H	A	M	A	M
46	A	H	A	M	A	M
47	A	M	A	M	A	M
48	A	M	A	M	A	M
49	A	M	A	M	A	M
50	A	M	S	L	S	M
51	A	H	S	M	A	H
52	A	M	A	M	A	M
53	A	H	A	L	A	L
54	A	M	A	H	A	M
55	A	H	S	M	S	L
56	A	H	A	H	A	H
57	A	H	A	H	A	H
58	A	H	A	H	A	H
59	A	H	A	H	A	H
60	A	H	A	H	A	H
61	A	H	A	H	A	H
62	A	H	A	H	A	H
63						DID NOT ANSWER QUE
64	S	M	S	M	S	M
65	A	M	A	M	A	M
66	A	H	A	H	A	H
67	A	H	A	H	A	H
68	A	M	S	M	A	H
69	A	H	S	L	N	L
70	A	M	A	M	A	M
71						DID NOT AN
72	A	M	A	H	S	H
73	A	H	A	M	S	L

ailed Survey Data

Line Quality		Rhythm		Pressure Variation	
Evaluation	Significance	Evaluation	Significance	Evaluation	Significance
A	H	A	H	A	H
A	H	A	H	A	H
S	M	A	H	S	M
A	H	A	L	A	L
A	H	A	L	A	H
A	H	A	M	A	M
A	H	A	H	A	H
A	H	A	H	A	H
A	H	A	M	A	M
A	M	A	M	A	H
A	M	A	L	A	M
A	H	A	M	A	M
A	H	A	H	A	M
A	H	A	M	A	M
A	H	A	M	A	M
A	H	A	H	A	M
A	H	A	H	A	L
A	M	A	H	A	H
A	H	A	M	A	M
A	H	A	M	A	H
A	H	A	M	A	H
A	H	A	H	A	H
A	H	S	M	A	M
A	H	A	H	A	H
A	M	A	M	A	M
A	M	A	H	A	M
A	H	A	H	S	M
A	H	A	H	A	H
A	H	A	H	A	H
A	H	A	H	A	H
A	H	A	H	A	H
A	H	A	M	A	M
A	M	A	M	A	M
A	H	A	H	A	H
A	H	A	H	A	H
A	M	A	H	A	H
A	H	A	M	A	H
A	H	A	M	A	H
A	H	A	H	A	M
A	H	A	H	A	H
A	H	A	H	A	H
A	H	A	H	A	M
A	H	A	H	A	H
A	H	A	M	A	M
A	H	A	H	A	H
A	M	A	M	A	H
A	H	S	L	S	L
A	H	A	H	A	H
A	H	S	M	A	H
A	H	A	M	A	H
A	H	A	H	A	M
A	H	A	H	A	H
A	H	A	M	A	M
A	H	A	H	A	H
A	H	A	H	A	H
A	H	A	H	A	H
A	H	A	H	A	H
A	H	A	H	A	H
A	H	N	L	A	H
A	H	A	L	A	H
A	H	A	H	A	H
A	H	A	H	A	H
A	H	A	H	A	H
A	H	A	H	A	H
A	H	A	H	A	H
IONS ONLY WROTE COMMENTS					
A	H	S	M	S	M
A	H	A	H	A	M
A	H	A	H	A	H
A	H	A	H	A	H
A	H	A	H	A	H
A	H	A	M	A	H
A	H	A	M	A	H
ER ANY QUESTIONS					
A	H	A	H	A	H
A	H	A	H	A	H

Table B1:

Id#	Speed		Writing Skill		Gen
	Evaluation	Significance	Evaluation	Significance	
1	A	H	A	M	N
2	A	H	A	H	N
3	S	M	S	M	N
4	A	H	A	H	N
5	A	H	A	H	N
6	A	M	A	M	N
7	A	H	A	H	N
8	A	H	A	H	N
9	A	H	A	H	N
10	A	M	A	M	N
11	A	M	A	M	S
12	A	H	A	H	N
13	A	H	A	H	N
14	A	M	A	H	N
15	A	H	A	H	N
16	A	H	A	H	N
17	A	M	A	H	S
18	S	M	A	H	S
19	A	M	A	M	N
20	A	H	A	H	N
21	A	M	A	M	N
22	A	M	A	M	S
23	A	M	A	M	S
24	A	M	A	M	N
25	A	M	A	M	N
26	A	H	A	H	N
27	A	H	A	H	S
28	A	H	A	H	N
29	A	H	A	H	N
30	A	H	A	H	N
31	S	M	A	H	N
32	A	H	A	H	N
33	A	L	A	M	N
34	A	H	A	H	N
35	A	H	A	H	S
36	A	M	A	M	N
37	A	H	S	M	N
38	A	M	A	H	N
39	A	M	A	M	N
40	A	H	A	H	S
41	A	H	A	H	N
42	A	M	A	M	N
43	A	H	A	H	S
44	A	M	A	H	N
45	A	H	A	H	N
46	A	H	A	H	S
47	A	M	A	M	N
48	S	M	A	H	N
49	A	H	A	H	N
50	S	L	S	M	N
51	A	M	A	H	N
52	A	M	A	H	N
53	A	H	A	H	N
54	A	H	A	H	S
55	A	H	A	H	S
56	A	H	A	H	N
57	A	H	A	H	N
58	A	H	A	H	S
59	A	H	A	H	N
60	A	H	A	H	N
61	A	H	A	H	S
62	A	H	A	H	S
63					DID NOT AN
64	A	H	A	H	N
65	A	H	A	H	N
66	A	H	A	H	N
67	A	H	S	M	S
68	A	H	A	H	N
69	A	M	A	H	N
70	A	M	A	H	N
71					C
72	A	H	A	H	N
73	A	M	A	H	N

ailed Survey Data

Performance	Penmanship		Hesitations		Pen lifts/Disconnects	
	Evaluation	Significance	Evaluation	Significance	Evaluation	Significance
L	A	H	A	M	A	M
	A	M	A	H	A	H
L	S	M	A	H	A	H
	A	H	A	H	A	H
	A	H	A	H	A	H
L	S	M	A	M	A	M
L	A	M	A	H	A	H
L	S	M	A	H	A	H
L	S	L	A	H	A	H
	S	L	A	M	A	H
L	A	M	A	H	A	H
L	S	M	A	H	A	M
L	S	M	A	H	A	H
L	S	L	A	M	A	H
L	N	L	A	H	A	H
L	A	H	A	H	A	H
L	A	L	A	H	A	M
L	A	H	A	H	A	H
	A	M	A	H	A	M
	S	M	A	H	A	H
L	S	M	A	H	A	M
L	S	M	A	H	A	H
L	S	M	A	M	A	H
L	A	M	A	H	A	H
	S	L	A	H	A	H
L	A	H	A	H	A	H
L	S	M	A	M	A	H
	A	H	A	H	A	H
	A	M	A	M	A	M
	S	L	A	H	A	H
L	A	H	A	H	A	H
L	A	L	A	L	A	M
L	S	L	A	H	A	H
L	A	H	A	H	A	H
	N		A	H	A	H
L	N	L	A	H	A	H
L	A	H	A	M	A	M
L	N	M	A	H	A	H
L	S	L	A	H	A	H
L	S	M	A	H	A	M
L	S	M	A	H	A	H
L	S	M	A	H	A	H
L	N	L	A	H	A	H
	A	H	A	H	A	H
	N		A	H	A	H
L	S	M	A	H	A	H
L	A	H	A	H	A	H
L	A	H	A	H	A	H
L	S	L	A	H	A	H
L	S	L	A	H	A	H
L	A	H	A	H	A	H
L	S	L	A	H	A	H
M	S	M	A	H	A	H
M	S	M	A	H	A	H
PER QUESTIONS ONLY WROTE COMMENTS						
L	S	M	S	M	A	H
L	A	M	A	H	A	H
L	A	H	A	H	A	H
M	S	M	A	H	A	H
L	N	L	A	H	A	H
L	N	L	A	H	A	H
L	A	M	A	M	A	H
NOT ANSWER ANY QUESTIONS						
L	S	M	A	H	A	H
	N		A	H	A	H

Table B1: D

Id#	Variation		Size - Absolute/Overall		Size - Relative: within	
	Evaluation	Significance	Evaluation	Significance	Evaluation	Significance
1	A	H	A	M	A	
2	A	H	A	H	A	
3			S	M	A	
4	A	H	A	L	A	
5	A	H	A	M	A	
6	A	M	A	L	A	
7	A	H	A	L	A	
8	A	H	A	M	A	
9	A	H	A	M	A	
10	A	H	A	L	A	
11	A	H	A	L	A	
12	A	H	A	H	A	
13	A	H	A	H	A	
14	A	M	A	M	A	
15	A	H	A	M	A	
16	A	H	N	L	A	
17	A	H	A	H	A	
18	A	H	A	M	A	
19	A	H	A	M	A	
20	A	H	A	H	A	
21	A	H	A	M	A	
22	A	M	S	M	A	
23	A	H	A	M	A	
24	A	H	A	H	A	
25	A	H	A	M	A	
26	A	H	A	H	A	
27	A	H	A	M	A	
28			A	M	A	
29	A	H	A	M	A	
30	A	H	A	H	A	
31	A	H	S	L	A	
32	A	H	S	M	A	
33	A	M	A	L	A	
34	A	H	A	H	A	
35	A	H	A	H	A	
36	A	H	A	L	A	
37	A	H	S	M	A	
38	A	M	A	M	A	
39	A	H	A	M	A	
40	A	H	A	H	A	
41	A	H	A	M	A	
42	A	H	S	M	A	
43	A	H	A	M	A	
44	A	H	A	H	A	
45	A	H	A	H	A	
46	A	H	A	H	A	
47	A	H	A	M	A	
48	A	M	A	M	A	
49	A	H	A	H	A	
50	A	H	S	M	A	
51	A	H	A	M	A	
52	A	H	A	M	A	
53	A	H	A	L	A	
54	A	H	A	L	A	
55	A	H	A	H	A	
56	A	H			A	
57	A	H	A	H	A	
58	A	H	A	H	A	
59	A	H	A	H	A	
60	A	H	A	H	A	
61	A	H	A	H	A	
62	A	H	A	H	A	
63						DID NOT ANSWER
64	A	H	A	M	A	
65	A	H	A	L	A	
66	A	H	A	H	A	
67	A	H	S	M	A	
68	A	H	A	M	A	
69	A	H	S	M	A	
70	A	H	S	M	A	
71						DID NOT ANSWER
72	A	H	S	M	S	
73	A	H	A	M	A	

Table B1: D

Id#	Slant - Relative: between Characters		Slant - Relative: between Words		Slant - R Evaluat
	Evaluation	Significance	Evaluation	Significance	
1	A	M	A	M	A
2	A	H	A	H	A
3	A	H	A	H	A
4	A	H	A	L	A
5	A	H	A	H	A
6	A	M	A	M	A
7	A	M	A	M	A
8	A	H	S	M	S
9	A	H	A	H	A
10	A	H	A	L	A
11	A	M	A	M	A
12	A	H	A	H	A
13	A	H	A	H	A
14	A	H	S	M	S
15	A	H	A	H	A
16	A	H	A	H	A
17	A	M	A	H	A
18	A	H	A	H	A
19	A	H	A	M	A
20	A	H	A	H	A
21	A	M	A	M	A
22	A	H	S	M	A
23	A	H	A	H	A
24	A	H	A	M	A
25	A	M	A	L	A
26	A	H	A	H	A
27	A	M	A	M	A
28			A	L	S
29	A	H	A	H	A
30	A	H	A	H	A
31	A	H	S	L	S
32	A	H	S	M	S
33	A	M	A	M	A
34	S	M	S	M	S
35	A	H	A	H	A
36	A	H	A	H	A
37	A	H	A	H	A
38	A	H	A	H	A
39	A	H	A	H	A
40	A	H	A	H	A
41	A	H	A	H	A
42	A	H	A	H	A
43	A	M	A	M	S
44	A	H	A	M	A
45	A	M	A	H	A
46	A	H	A	H	A
47	A	H	A	M	A
48	S	L	S	L	S
49	A	M	A	M	A
50	S	H	S	H	N
51	A	H	A	H	S
52	A	H	A	H	A
53	A	H	A	H	A
54	A	H	A	H	A
55	A	H	A	H	A
56	A	H	A	H	A
57	A	H	A	H	A
58	A	H	A	H	A
59	A	H	A	H	A
60	A	H	A	H	A
61	A	H	A	H	A
62	A	H	A	H	A
63					DID NOT ANSWER
64	S	M	S	M	S
65	A	H	A	H	A
66	A	H	A	H	A
67	A	H	A	H	A
68	A	H	A	H	A
69	A	H	A	H	S
70	A	M	A	M	A
71					DID NO
72	S	M	S	M	S
73	A	H	A	H	A

ailed Survey Data

ive: between Lines Significance	Spacing - Absolute/Overall Evaluation Significance		Spacing - Relative: between characters Evaluation Significance	
M	A	H	A	H
H	A	H	A	H
H	S	M	A	H
L	A	H	A	H
H	A	L	A	H
M	A	M	A	M
L	A	L	A	M
M	A	H	A	H
H	A	H	A	H
L	A	L	A	H
M	A	L	A	M
M	A	M	A	H
H	A	H	A	H
M	A	M	A	H
H	A	H	A	H
H	N	L	A	H
M			A	M
H	A	M	A	H
M	A	M	A	H
H	A	H	A	H
M	A	H	A	H
M	A	M	A	H
H	A	M	A	H
M	A	H	A	H
L	A	H	A	H
H	A	H	A	H
M	A	M	A	H
L	A	H	A	H
H	A	H	A	H
M	A	M	A	H
L	A	M	A	H
M	A	H	A	H
M	A	M	A	M
M	A	M	A	M
H	A	H	A	H
H	A	M	A	H
H	S	M	A	H
H	A	H	A	H
M	A	M	A	H
H			A	H
M	A	M	A	H
M	A	H	A	H
M	A	H	A	H
M	A	H	A	H
M	A	H	A	H
H	A	H	A	H
M	A	M	A	H
L	A	M	A	M
M	A	H	A	H
	S	M	S	H
M	A	H	A	H
H	A	M	A	M
H	A	M	A	H
H	A	M	A	H
H	A	H	A	H
H	A	H	A	H
H	A	H	A	H
H	A	H	A	H
H	A	H	A	H
H	A	H	A	H
QUESTIONS ONLY WROTE COMMENTS				
M	A	H	A	H
H	A	L	A	H
H	A	H	A	H
H	S	M	A	H
H	A	M	A	H
M	A	H	A	H
M	A	H	A	H
ANSWER ANY QUESTIONS				
M	A	H	S	M
H	A	H	A	H

Table B1: D

Id#	Spacing - Relative: between words		Spacing - Relative: between lines		Personality	
	Evaluation	Significance	Evaluation	Significance	Evaluation	Significance
1	A	M	A	M	N	L
2	A	H	A	H	N	
3	S	M	S	M	N	L
4	A	M	A	M	N	
5	A	M	A	L		
6	A	M	A	M	N	L
7	A	M	A	L		
8	A	H	S	M	N	L
9	A	H	A	M	N	L
10	A	M	A	L	N	
11	A	M	A	M	N	
12	A	H	A	M	N	L
13	A	H	A	H	N	L
14	S	M	S	M	N	
15	A	H	A	M	N	L
16	A	H	A	H	N	L
17	A	H	A	M		
18	A	M	S	M	N	L
19	A	M	A	M		
20	A	H	A	H	N	
21	A	H	A	H	N	L
22	S	M	S	M	N	L
23	A	H	A	H	N	
24	A	H	A	H	N	L
25	A	M	A	M	N	L
26	A	H	A	H		
27	A	M	A	M	N	L
28	A	H	A	M	N	L
29	A	M	A	M	N	
30	A	M	A	L	N	
31	S	M	S	M	N	
32	S	M	S	M	N	L
33	A	M	A	M	N	L
34	A	M	A	M	N	
35	A	H	A	H	N	L
36	A	H	A	M	N	
37	A	H	S	M	N	L
38	A	H	A	H	N	L
39	A	H	A	M	N	L
40	A	H	A	M	N	
41	A	H	A	M	N	L
42	A	H	A	M	N	L
43	A	M	S	M	N	L
44	A	M	A	M		
45	A	M	A	M	N	L
46	A	M	A	M	N	L
47	A	M	A	M	N	
48	A	M	A	M	N	L
49	A	H	A	H	N	L
50	S	H	S	M	N	
51	A	M	A	M	N	L
52	A	M	A	M	N	
53	A	H	A	M	N	
54	A	H	A	H	N	
55	A	H	A	H	N	L
56	A	H	A	H	N	L
57			A	H	N	
58	A	H	A	H		
59	A	H	A	H	N	
60	A	H	A	H	N	L
61	A	H	A	H	N	
62	A	H	A	H	N	
63						DID NOT ANSWER QUE
64	S	M	S	M	S	M
65	A	H	A	H	N	L
66	A	H	A	H	N	L
67	A	H	A	H	S	M
68	A	H	A	H	N	L
69	A	H	A	H	N	L
70	A	H	A	H	N	L
71						DID NOT AN
72	A	H	S	M	N	L
73	A	H	A	H	N	

APPENDIX C

Ranking of 34 Habit Areas

Table C1: Rank

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

ng of 34 Habit Areas

		Ranking				
11 - 20 Years	21+ Years	Overall Sort	0-3 Year Sort	4-10 Years Sort	11-20 Years Sort	21+ Years Sort
24	27	1	1	1	1	1
23	27	5	3	3	6	2
24	27	2	13	4	3	3
24	27	3	14	5	4	4
23	27	6	15	8	8	5
24	26	4	2	2	2	6
23	26	8	5	7	7	7
17	26	20	21	18	26	8
24	25	7	4	6	5	9
23	25	9	6	9	9	10
22	25	10	7	10	13	11
23	25	11	16	11	10	12
23	25	14	18	21	11	13
22	25	12	17	13	15	14
22	25	15	9	25	16	15
20	25	18	10	22	20	16
22	24	13	8	12	14	17
21	24	16	19	14	17	18
23	22	17	20	15	12	19
21	22	19	11	16	18	20
20	22	21	12	17	21	21
18	21	22	23	23	23	22
17	21	23	24	24	27	23
21	20	26	27	29	19	24
18	19	25	25	20	24	25
16	17	27	26	26	29	26
18	17	28	30	30	25	27
16	16	29	31	27	30	28
16	16	30	28	31	31	29
20	15	24	22	19	22	30
17	12	31	29	28	28	31
2	10	32	32	32	32	32
-22	-22	33	34	33	33	33
-22	-23	34	33	34	34	34

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