

Statistical Observations of Disguised Signatures

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In an effort to expand on the knowledge of signature disguises most commonly used by writers, 128 state police cadets were given a survey instrument and asked to provide signature exemplars. These cadets were then instructed to disguise their normal signatures. A comprehensive index of seventeen different disguise methods was utilized to analyze what techniques of deception had been employed by each writer. While previous research regarding the relationship between education and disguise was directed towards extended handwriting, this study focused on the effects of education on disguise in signatures. From the data collected, most subjects used between one and three methods of disguise with the most popular method being “*altered capital letters*” in disguising their name. A weak relationship was noted between education and the writer’s ability to successfully disguise his/her signature. Additional findings are discussed in the study. The information from this study should prove useful for forensic documents examiners encountering the phenomenon of disguise in a questioned signature.

Introduction

Handwriting comparison involves a meticulous comparison of questioned handwriting with a known writer’s handwriting in order to determine authorship. Rather than simply reviewing the handwriting for pictorial similarities that many individuals would readily recognize (such as identifying a piece of mail as having been sent by a relative). A document examiner reviews the handwriting for subtle, identifying features. A few examples of these features include connecting strokes between letters, spacing, beginning strokes, and the proportions of the letters. While performing a comparison, the examiner is cognizant of certain problems that could effect the writing, such as tracing, simulation of another individual’s handwriting, or distortion of the handwriting caused by unintentional factors, such as writing position or by intentional distortion. Handwriting disguise has been described as “... the willful modification of a person’s natural writing for the purpose of concealing identity” (Harris, 1953).

The use of disguise in handwriting is one of the most intriguing problems of the questioned documents discipline that often results in inconclu-

sive findings (Osborn, 1946). The phenomenon of disguise has been documented in major texts, (Osborn, Hilton, Harrison, and Conway) journal articles, and professional papers since the formalization of forensic documents examination in the early 1900s. The majority of information on disguise relates to lengthier forms of handwriting, such as whole pages of text. Far fewer studies (Herkt’s, Alford’s, and Michel’s) have scrutinized the methods used in disguising individual writer’s own signatures. With holographic documents, Harrison has observed, “few forms of disguise are consistently retained throughout the whole of an extended passage of handwriting” (Harrison, 1981). In contrast to lengthier texts, signatures are characterized by their limited amount of writing, which is not necessarily a disadvantage for examination purposes. Hilton notes that when a person signs his name, “he is carrying out one of his most common writing acts” (Hilton, 1982). Therefore the advantage of a signature is that “in time, it becomes highly individualized, often in a style quite distinct from the writer’s other handwriting” (Hilton, 1982), and “it will include elements which are generated from a habit too strong to be eradicated” (Baker, 1955). The efforts of writers to conceal their identity through disguise

in their signatures present a special challenge for the document examiner.

Conceptual Framework

A review of various publications documenting disguise in handwriting in general revealed that much of this information had been experientially based. While this information is significant in its detail and insights, it also provides an initiative for empirical testing and analysis. Hull, Regent, Konstantinidis, Stangohr, Harris, Keckler, and Galbraith have added to the knowledge of disguise in extended forms of handwriting through their collection of data and statistical observations gleaned from it (Hull, 1991; Regent, 1977; Konstantinidis, 1987; Stangohr, 1968; Harris, 1953; Keckler, 1997; Galbraith, 1979). Fewer studies have dealt specifically with disguised signature analysis (Alford, 1970; Michel, 1978; Herkt, 1986). For the most part, these studies were limited to reporting the percentage of disguise methods used by writers. An exception is Galbraith's study, which utilized exploratory statistical analysis by incorporating nonparametric measures of analysis into her study (Galbraith, 1979).

One of the questions continually addressed in the literature regarding both extended handwriting and signature disguise is, "What method is most often used by writers attempting to conceal their identity?" In both signature and handwriting review articles, several authors indicate a change in slant is the most common disguise (Konstantinidis, 1987; Harris, 1953; Davidson & Keckler, 1981; Keckler, 1997). Other authors, Alford, Hull, Galbraith, and Herkt, refer to "alteration of capital letters" as the most popular method. In the case of signature disguise, the alteration of capital letters refers to altering the first letter of each proper name or initial in the signature. Muchlberger (1990) noted in his review of nine case studies that block printing was the most often utilized method of disguise. Michel (1978) produced the only study indicating that writers returned to a copybook style (as learned in grade school) as the most common form of disguise. His study was conducted utilizing fifty German volunteers ranging in age from 20 to 69. Nationality and a smaller number of participants may have influenced the outcomes in his particular study. (NOTE: Michel also allowed his participants to practice their disguises and submit the best product of their efforts. This may

have led to a combined effort on the part of writers to ascertain the method they felt most significantly altered the pictorial aspects of their signatures.)

Galbraith's study of the influence of education on writers' ability to disguise utilized a subjective Likert scale ranging from "pictorial change-consistent" to "no pictorial change-not consistent" to measure 23 writers' abilities to successfully disguise their extended handwriting. Galbraith did not elaborate on how her 23 participants were chosen. "Pictorial change" in her study refers to a change in the general appearance of the writing. This general appearance allows laypeople to discern a writer's identity based on familiarity with the appearance of that person's handwriting. "Consistency" refers to the writers' ability to maintain a consistent pictorial appearance within the 140-word story they were producing while attempting to disguise their handwriting. By utilizing two nonparametric measures to test her hypothesis that education did effect writers' ability to successfully disguise, Galbraith's study rejected the hypothesis, demonstrating that education did not effect disguise.

Hull conducted a study of 160 random, volunteer writers to determine if certain disguise techniques were employed by writers based on their degree of education and if education had an effect on the number of disguises the writers utilized in their extended handwriting sample. Hull applied an index of sixteen methods of disguise to categorize his characteristics of deception. In reviewing his final percentages and numbers, he found that education had an influence on the particular disguise and number of disguises writers were utilizing. Hull's study indicated that less educated individuals were more likely to introduce hand printing into their extended writing (as a deviation from their normal cursive writing). Additionally, the more educated writers were utilizing more disguises in their writing samples than their less educated counterparts. Writers incorporated an average number of seven techniques of disguise (out of the possible index of sixteen) into their extended writing. In contrast to Galbraith's study, Hull utilized more objective variables in the form his "techniques of disguise." However, unlike the previous study, Hull reported his percentages but performed no other tests on his data.

The techniques of disguise in handwriting and signatures cataloged by researchers have varied from as few as six (Michel, 1978) to as many as

Hull's sixteen (Hull, 1991; Hull, 1993). For the present analysis, seventeen techniques of signature disguise were examined in order to gain as much insight into the use of one or several methods in combination with each other. These "attributes of disguised writing" have been culled from the literature relating to both handwriting and signature disguise (Hart, 1985). These characteristics range from common methods of *altered capital letters* and *altered slant* to more esoteric forms as *altered letter construction* and *omitted letters*. A complete listing of variables can be reviewed in Appendix A.

These forms of disguise are meant to be considered mutually exclusive of each other to identify their use in combination or absence of each other. The disguises are not meant to be overlapping. For example, a writer altering the construction of the capital letter of his first name would not have two forms of disguise (*altered capital letters* and *altered letter construction*), the predominant variable, *altered capital letter*, would be the only disguise considered for that instance. Therefore, each of the respondent's signatures was carefully examined to determine the exclusivity of each form of disguise being utilized. Despite the relatively small amount of writing associated with signatures there remains the possibility that several disguises and possibly diametrically opposite disguises could be incorporated into one signature. For example, an individual who normally signs his name "J. Henry Wigum" could spell out his first name ("John") while subtracting a letter from his last name ("Wigm") to deviate from his normal style of writing, thus incorporating two opposite methods, *added letters* and *omitted letters*, into his deceptive signature.

This study specifically addressed signature disguise as opposed to previous studies of lengthier forms of handwriting, such as the Galbraith and Hull studies. The study first addressed which of the most popular methods of disguise writers utilize, since literature has been conflicting on this issue. The benefit of determining or reiterating the most popular methods of disguise in signatures is to assist examiners in directing the course of their examinations.

Second, the studies conducted by Galbraith and Hull relating to education as an effect on utilizing disguises were revisited from the perspective of a "signature only" analysis. For the analysis relating to Galbraith's "ability to disguise" study, a similarly subjective dependent variable was utilized to rank order the degree of pictorial alter-

ation of the respondents' signatures. This variable, entitled *recognizability*, consisted of the following five ranges: *completely altered*, *significantly altered*, *somewhat altered*, *slightly altered*, and *not at all altered*. To test Hull's findings, the sum of disguise techniques was calculated for each writer and designated as the dependent disguise variable "*disguise index*" to test against the independent variable, education. Both the *recognizability* and *disguise index* were tested using discriminating, nonparametric measures of analysis (as opposed to just the *recognizability* variable).

Third, from the aforementioned *disguise index* and *recognizability* variable, the relationships between these dependent variables and independent variables was tested. The independent variable information collected from survey respondents included *age*, *gender*, *dominant writing hand*, and *years of education*. The relationships between the dependent variables (such as one variable's use predicting another) were also examined. The expectation of these statistical tests was that relationships between the variables existed and could be demonstrated by using nonparametric methods of measurement. This information was gathered to possibly benefit examiners as they develop strategies for analyzing documents where the possibility of disguised writing exists.

Finally, the hypothesis that fewer disguises would be utilized in signatures than used in lengthier forms of handwriting was tested. The *disguise index* was again used to glean information about what possible average number of disguises were found in signatures.

Methods and Materials

The methodology followed in sample collection was to gather a cross section of writers, who would provide an adequate number of normal signatures for comparison with their disguised signatures. In order to eliminate the use of different writing instruments and changes of environments (i.e. allowing writers to take the survey instruments home), the subjects were given only a short period of time to produce both their standards and disguised signatures. Once the signatures had been collected, a normal examination was performed. The standard signatures were examined for variations and then compared to the disguised signatures to determine what methods had been utilized and how successful the methods were in

deviating from the normal signatures of the writers. The data was then placed into a file for analysis with a SPSS statistical analysis software program (SPSS Version 7.1, 1995).

The surveys utilized for the study were incorporated into an overall lesson plan for 128 state police cadets undergoing normal training. For this particular lesson plan, cadets were given the survey forms midway through a period of instruction and directed to sign their "normally presented" signatures fifteen times at the designated areas on the front of the one page survey form. Later in the period, the cadets were asked to provide a disguised signature on the reverse side of their survey form, without looking at their signatures on the front of the sheet.

The respondents' ages ranged from 22 to 33 years old. Seventy-six percent of the cadets were between the ages of 24 and 27. Ninety-five percent were males, with 85% of the males being white, non-Hispanic writers. Ninety percent of the 128 respondents were right handed. Seventy-five percent of the respondents had an Associates degree or higher, and of these respondents, 60% had a Bachelors degree.

Results

An examination of the data revealed the most prevalent method of disguise was *altered capital letters*. Sixty-three percent of the writers utilized this method in disguising their signatures. Following in popularity, 26% of the writers used *altered letter construction* in their disguised signature, and 24% of the writers used *omitted letters*

as a means of creating a deceptive signature. The full range of findings can be viewed in Figure 1 of the study.

The non-parametric measure of Spearman's Rho or r was utilized to test the hypothesis that *education* does have an effect on a writer's ability to disguise his/her signature (Figure 2). It was also used to test the effect of education on the number of disguises the writer incorporated into his/her signature (Figure 2). The Spearman's r statistic is qualitative in nature and ranges from insignificant, at less than .10, to a moderate relationship indicated at .50, and an exceptional relationship at .80. While an exceptional relationship in the area of .80 would be unusual, more typical of this qualitative measure are relationships falling between the .10 to .50 scale.

The test of *education* affecting the *recognizability* variable revealed a Spearman's r -value of .133. This value, despite being weak, indicates that a relationship exists between *education* and ability to significantly alter one's signature; that is, the more educated the individuals, the better their ability to pictorially alter their signature. Nothing of significance was found to indicate that education has an effect on the number of disguise methods a writer uses. In analyzing the dependent, *disguise index* and *recognizability* variables with the independent, *dominant writing hand* and *age* variables, nothing of significance was noted to indicate relationships between these independent and dependent variables. However, a relationship appeared between the *disguise index* and the *recognizability* variables. With an r value of -.181, the correlation suggests a natural pro-

Dependent Variables Examined	Education	Age	Dominant Writing Hand	Disguise Index
Disguise Index	.028	.008	.047	---
Recognizability	.133	.056	.027	-.181*

*Statistically significant at the .05 level

Figure 2. Spearman's Rho Values.

	Age Groups				Dominant Hand				Gender				All Writers	
	22 to 25		26 to 33				Left		Male		Female		Totals	
	%	N	%	N	%	N	%	N	%	N	%	N	%	N
Disg-1 All Caps	62.7	37	63.8	44	62.6	72	69.2	9	61.2	74	100	7	63	81
Disg-2 Slw Spd	15.3	9	14.5	10	13	15	30.8	4	15.7	19	--	--	15	19
Disg-3 Fast Spd	10.2	6	7.2	5	8.7	10	7.7	1	8.3	10	14.3	1	9	11
Disg-4 Alt Ltr	28.8	17	23.2	16	26.1	30	23.1	3	8.3	10	14.3	1	26	33
Disg-5 Copybk	13.6	8	10.1	7	13	15	--	--	11.6	14	14.3	1	12	15
Disg-6 Small Ltr	3.4	2	2.9	2	3.5	4	--	--	3.3	4	--	--	3	4
Disg-7 Lrg Ltr	5.1	3	14.5	10	8.7	10	23.1	3	10.7	13	--	--	10	13
Disg-8 Onit Ltr	23.7	14	24.6	17	22.6	26	38.5	5	24	29	28.6	2	24	31
Disg-9 Adds Ltr	6.8	4	4.3	3	6.1	7	--	--	5	6	14.3	1	5	7
Disg-10 Crwd Nm	10.2	6	13	9	11.3	13	15.4	2	11.6	14	14.3	1	12	15
Disg-11 Strchs Nm	1.7	1	1.4	1	.9	1	7.7	1	1.7	2	--	--	2	2
Disg-12 Scrwl Nm	6.8	4	5.8	4	6.1	7	7.7	1	5.8	7	14.3	1	6	8
Disg-13 Alt Slant	10.2	6	7.2	5	7.8	9	15.4	2	9.1	11	--	--	9	11
Disg-14 Crude Ltr	5.1	3	4.3	3	5.2	6	--	--	5	6	--	--	5	6
Disg-15 Alt Tm Stk	13.6	8	13	9	13.9	16	7.7	1	12.4	15	28.6	2	13	17
Disg-16 Alt Bslne	1.7	1	2.9	2	1.7	2	7.7	1	2.5	3	--	--	2	3
Disg-17 Offhand	8.5	5	4.3	3	5.2	6	15.4	2	6.6	8	--	--	6	8

Figure 1. Demographics by disguises used.

pensity for the *recognizability* of the signature to decrease as the number of disguises increase.

The *disguise index* revealed that of the seventeen possible disguises studied, the cadets used as many as five forms of disguise and as few as

one (Figure 3). The average number of disguises being by individual writers was two, with the vast majority of writers using between one and three of the disguise variables designated for study. Bivariate analysis failed to show any relationships

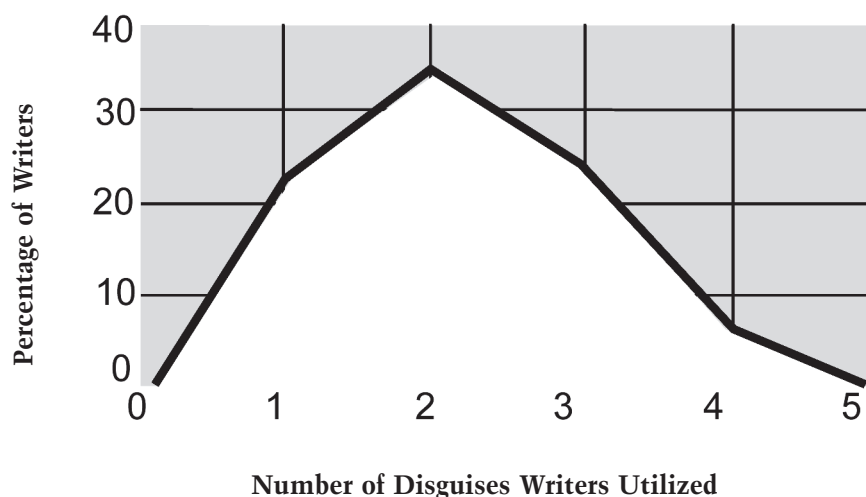


Figure 3.

between combinations of disguise methods. Essentially, writers failed to show any penchant for using certain disguise techniques in combination with each other.

Discussion

This study was undertaken to add additional information to the specific topic of disguise in signatures. In Parker's case study involving disguised signatures, he relates "intentional distortion can often restrict efforts to identify the writer by handwriting comparison" (Parker, 1989). Because of this problem, the subject deserves continued study.

While the findings of this study were constrained by the homogenous nature of the test group, the introduction of writers of many ages and backgrounds could have made analyses of the trends found in the study more difficult. Rather this study was undertaken as an initial step toward the formidable task of making statistical inferences about the various populations of writers. These differing populations would each re-

quire attention and study; whereby, a compilation of studies could accurately reflect trends in the heterogeneous population of writers at large. The findings of this study revealed that *altered capital letters* was the primary source of deception attempted by the sample writers (Figure 1). Additionally, *altered construction of letters* and *omitted letters* were significant features most often utilized. This finding reinforces the studies conducted by Alford, Hull, Galbraith and Herkt, while differing from several past studies that indicated *altered slant* was the most popular form of disguise used (Davidson, 1981; Harris, 1953; Keckler, 1997; Konstantinidis, 1987).

Despite the weak correlation coefficient, results of this signature study contradicted Galbraith's study of disguise in extended handwriting. This study found that education did have an effect on the writer's ability to effectively disguise. A caveat to this analysis is the fact that both Galbraith's variable and the *recognizability* variable used in this signature study are highly subjective measures and would be difficult to establish replication in future studies. Despite the use

of objective techniques of disguise, which showed variation when observing the percentages of use,

(Figure 4), the analysis between *education* and *number of disguises* failed to reveal a relation-

	Below Bachelor's Degree		Bachelor's Degree		Above Bachelor's Degree	
	%	N	%	N	%	N
Disg-1 All Caps	68.9	42	66.7	36	23.1	3
Disg-2 Slw Spd	11.5	7	18.5	10	15.4	2
Disg-3 Fast Spd	8.2	5	11.1	6	15.4	2
Disg-4 Alt Ltr	24.6	15	31.5	17	7.7	1
Disg-5 Copybk	16.4	10	9.3	5	--	--
Disg-6 Small Ltr	3.3	2	3.7	2	--	--
Disg-7 Lrg Ltr	8.2	5	13	7	7.7	1
Disg-8 Omit Ltr	23	14	22.2	12	38.5	5
Disg-9 Adds Ltr	4.9	3	5.6	3	7.7	1
Disg-10 Crwd Nm	9.8	6	3	7	15.4	2
Disg-11 Strchs Nm	--	--	3.7	2	--	--
Disg-12 Scrwl Nm	4.9	3	5.6	3	15.4	2
Disg-13 Alt Slant	9.8	6	7.4	4	7.7	1
Disg-14 Crude Ltr	3.3	2	3.7	2	15.4	2
Disg-15 Alt Tm Stk	11.5	7	16.7	9	7.7	1
Disg-16 Alt Bslne	3.3	2	1.9	1	--	--
Disg-17 Offhand	4.9	3	5.6	3	15.4	2

Figure 4. Disguises by years of education.

ship. Using nonparametric, statistical measures, these findings contradict the results of Hull's study relating to education and the number of disguises used in extended forms of handwriting. This study also reflected the natural deterioration of the ability to recognize a signature as the number of disguises increased.

Once the disguise methods were viewed collectively, a trend emerged showing that 88% of the writers incorporated from one to three vari-

ables of deception into their signatures. This number differs from the average of seven out of sixteen techniques of disguise that Hull found in his analysis of extended writing. No more than five disguises were used in any respondent's signature, and only in rare instances did writers use five methods (2% of all writers), or fail to use any method of disguises (2% of all writers) (Figure 1). Most writers, 37% of all respondents, implemented two methods of disguise in their sig-

Appendix A

Disguise #	Description
1	<i>Altered Capital Letters.</i> This method involves changing the capital letters in a manner that deviates from the writer's normal forms.
2	<i>Slower Writing Speed.</i> This method entails slowing of normal writing speed to give a different pictorial appearance in the signature. Slow writing speed was detected through observation of speed movements in the writing, the depth of the trough left by the point of the writing instrument and the thickness of the ink line.
3	<i>Faster Writing Speed.</i> This method was detected utilizing similar methods as discussed with the previous variable.
4	<i>Altered Letter Construction.</i> This method refers to the writer constructing letters in a manner differing from his normal design.
5	<i>Copybook Style.</i> Handwriting develops individually over time, but if a writer reverts to a cursive copybook style as learned in grade school, the stylized, individuality of the signature is diminished. The writer would, in essence, be drawing the letters of his/her signature.
6	<i>Smaller Letter Height.</i> Reduction in the height of the signature to possibly alter the signature.
7	<i>Larger Letter Height.</i> Enlargement in the height of their signature to possibly alter the signature.
8	<i>Omitted Letters in Name.</i> Purposely omitting letters of a name.
9	<i>Added Letters in Name.</i> This disguise entails adding letters to a signature.
10	<i>Crowded Name Together.</i> The writer linearly condenses the normal signature.
11	<i>Stretched Name.</i> The writer linearly expands the signature.
12	<i>Scrawled All or Part of the Name.</i> The writer introduces large sweeping movements and simplified forms into the signature, decreasing legibility.
13	<i>Altered Slant of the Signature.</i> Many writers normally slant their signature to the right, therefore slanting purposely to the left would represent a conscious effort to alter the normal writing style.
14	<i>Use of Crude Letters</i> in all or part of the signature. Writers most often produce signatures with normally formed cursive letters, therefore, the introduction of crudely printed letters would represent a deviation from the norm.
15	<i>Altered Terminal Stroke</i> of a signature. An example of this disguise would be if the writer John Doe normally writes his signature with the terminal stroke of the "e" pointing upward but changes that stroke to point downward.
16	<i>Altered Baseline Conformation.</i> For example, some writers tend to write very carefully on a printed line of a personal check or notepad paper and a deviation would change the normal writing style.
17	<i>Indications of Offhand Writing.</i> Because most writers lack control of the writing instrument -- when using the unaccustomed hand, indications of offhand writing exhibit themselves in their signatures.

natures, which would most likely be *altered capital letters* and *altered letter construction*.

Twenty years ago, Fred Webb related that disguise is "not a new subject, but it is worthy of frequent reconsideration by document examiners" (Webb, 1978). This study was conducted to reconsider disguise and direct research specifically towards disguised signature analysis. The findings regarding the most common methods of deception in writing reinforce earlier studies while adding information from an expanded index of disguise techniques. This study contradicts the previous studies relating to disguise in extended handwriting. This study found a nominal relationship between education and ability to disguise but no relationship between education and the number of disguises used. Further analysis revealed that the number of disguises deteriorated the recognizability of a signature. Despite limitations of the analysis, this study provides examiners with new information, which may assist in the examination of questioned signatures.

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