

Habits Observed In Naturally Written Numbers

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Naturally written numbers tend to be individualized to a particular writer as they depart from the copybook style. Initial and ending strokes, ornamentation, design simplification, overall slant and the interrelationship of component parts in the more complex digits "2," "3," "4," "6," "8," and "9" comprise these basic qualities. This paper will explore the formation of naturally written numbers and the frequency of occurrence of at least one set of numbers connected by the writer in their three-page exemplar. Two hundred participants completed a four-page exemplar consisting of three pages of naturally executed numbers and one page of disguised numbers. For this study, the three pages of naturally written numbers were examined and percentages determined as to frequency of occurrence of habits observed in the three-page exemplars. Out of the 200 participants in this study, 37% connected at least one set of numbers using a connecting stroke. The percentage of writers using the snowman "8" and the crossbar "7" were also assessed. This paper lists the combinations of numbers connected by a connecting stroke and the percentage of usage of specific number formations.

Introduction

The process of examining numbers is the same as that used for handwriting and hand printing. Naturally written numbers tend to be individualized to a particular writer as they depart from the copybook style (Alford, 1965). As with any identification, form, writing quality, and variation are fundamental factors in the identification of numbers. Initial and ending strokes, ornamentation, design simplification, overall slant, and interrelationship of component parts in the more complex digits "2," "3," "4," "6," "8," and "9" comprise the basic design of these factors (Hilton, 1970). Additionally, size, space, baseline alignment and positioning of multiple numbers contain the combination of characteristics that are identifiable to one writer. This research will focus on the interrelationship of the component parts of naturally written numbers. More specifically, how often will a document examiner observe connecting strokes between two numbers? Out of 200 participants, how many use a "snowman 8" or cross the staff of the "7"? This paper will discuss these and other habits observed

in naturally written numbers as well as the habits of initial stroke formation among the 200 writers.

Methods and Materials

For this study, the author obtained known number exemplars from 200 participants. Geographically, the study pool encompasses the United States and the ages of the participants are between 16 and 81. With the exception of those under 18 years of age, the average education of each participant is four years of college. Each participant was asked to complete a four-page exemplar using a black ballpoint pen. All four pages contain several telephone numbers and differing dollar amounts. Even though the number combinations were the same on all four pages, the location of the entry differed from page to page with each number being repeated 138 times. The participant was instructed to complete the first three pages naturally. The fourth page instructed the participant to alter or disguise the set of numbers to avoid identification. The various methods of disguise were discussed in prior research (Seaman-

Kelly, 1999). The first three pages of the four-page exemplar were examined to determine the percentage of writers whose naturally written numbers contain the following characteristics: connecting two of their numbers; use of the various number combinations; a "2" with a lower loop; presence of a loop in the terminal stroke of both the "3" and the "5"; a "tent-shaped or triangle" "4"; a crossbar on the staff of the "7"; use of the "snowman 8", the more traditional "8" made similar to a capital "S" formation, and the "8" made with the initial stroke in the upper left corner with the body formed in a counter-clockwise movement terminating in the left upper corner; and use a dollar sign (\$) with one staff or two.

Results

Frequency of Connected Numbers

Connecting one number to another with a connecting stroke is an individual characteristic and can be significant because the writer is not taught to connect the numbers. According to Hilton, not only are the connected numbers an identifying element, but the movement involved in making the connection is subject to individual treatment (1970). The percentage of connected numbers written by the 200 participants in this study are as follows (Table 1):

Numeral	Percentage of Connectedness to a Succeeding Numeral										Example
	0	1	2	3	4	5	6	7	8	9	
1	1										10
2	5	3	1		3		9		6	7	20
3	3	3			1		4		2	1	34
4	1	1					2				40
5	34/4*	3			3		5		11		50/50
6							1		1		66
7	1					1				3	70
8 (One-piece)	22				7	4	16		10		88
8 ("Snowman")	<1		2				<1		<1		92
9				<1		1					96

Table 1

NOTES:

1. The number "1": 1% of the writers connected the "1" to a "0."
2. The number "2": 5% of the writers connected the "2" to a "0"; 3% connected the "2" to a "1"; 1% connected the "2" to a "2"; 3% connected the "2" to a "4"; 9% connected the "2" to a "6"; 6% connected the "2" to a "8"; 7% connected the "2" to a "9."
3. The number "3": 3% connected the "3" to a "0"; 3% connected the "3" to a "1"; 1% connected the "3" to a "4"; 4% connected the "3" to a "6"; 2% connected the "3" to a "8"; and 1% connected the "3" to a "9."

4. The number "4": 1% connected the "4" to a "0"; 1% connected the "4" to a "1"; and 2% connected the "4" to a "6."
5. The number "5": 34% of the writers connected the "5" to a "0" with the horizontal top stroke. The ending loop exiting the bowl of the "5" connecting to a "0" was used by 4% of the 200 writers; 3% of the writers connected the "5" to a "1"; 3% connected the "5" to a "4"; 5% connected the "5" to a "6"; 11% connected the "5" to an "8."
6. The number "6": 1% connected the "6" to a "6"; 1% connected the "6" to an "8."
7. The crossbar "7": The crossbar was the connecting stroke in the following connections: 1% connected the crossbar "7" to a "0"; 1% connected the crossbar "7" to a "5"; 3% connected the crossbar "7" to a "9" (Fig.1). The English-American "7": The downstroke of the "7" connected to a "9" in 1% of the participants (Fig. 2).

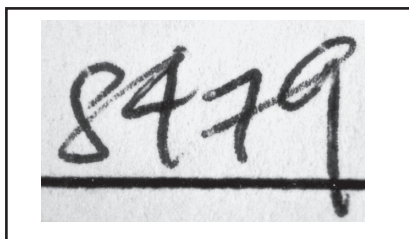


Figure 1. Three percent of the 200 participants used the crossbar to connect to the preceding "9."

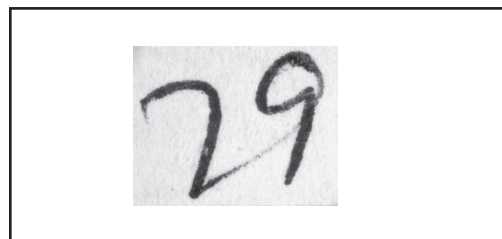


Figure 2. One percent of the participants used the terminal end of the staff on the English-American "7" to connect to the preceding "9."

8. The "S" formation "8": 22% connected the "8" to a "0"; 7% connected the "8" to a "4"; 4% connected the "8" to a "5"; 16% connected the "8" to a "6"; and 10% connected the "8" to an "8."
The "snowman "8": 14% of the participants used a "snowman 8". One writer, or less than 1%, connected the snowman "8" to a "0," "6," or "8." Two percent connected the snowman "8" to a "2."
9. The number "9": 1% connected the "9" to a "6"; one writer, or less than 1%, connected the "9" to a "4."

Thirty-seven percent of the 200 participants connected at least one set of numbers. More specifically, thirty-five (35) writers connected only one set of numbers with the first number being a "5," "8," or "2." Sixteen (16) writers connected two sets of numbers with the "5" and "8" or the "8" and "5" combination occurring most frequently. Twenty-two (22) writers connected three or more sets of numbers with the first number being a "2," "5," or "8."

Internal Consistency in Numbers

G. A. Dawson wrote internal consistency is present in handwriting when the same or similar

strokes or sequences of strokes occur in different letters (1986). In the course of this research, internal consistency among numbers was evident (Table 2) in the exemplars of a few of the 200 participants.

Internal consistency was observed in the beginning and ending formations of numbers. Fifteen percent of the 200 participants began the "2," "3," and "7" with a similar formation of a small loop or retrace in the initial stroke.

Out of 200 writers, 25% had a lower ending loop in both the number "3" and the number "5." As a general rule, if the writer made an upward curl or angled terminal "tic" inside the bottom bowl of the "3," that same movement would be found in

the bottom bowl of the "5" (Fig. 3). As with all rules, there will be exceptions and this study is no different. Out of 200 writers, 5% made an ending loop on the "3" and not on the "5." Two percent of the writers made a lower loop on the "5" and not on the "3."

Individual Habit Formation of Numbers

The individual numbers were examined for formation and the placement of the initial stroke. Conway observed that it is not difficult for many writers to develop several classes of numerals and occasionally to use them interchangeably without being fully aware of the extent of their own variations (1959). The results of this and the Giles study (1999) indicated that a significant number of individual writers use more than one form of a number. This section of the paper will discuss the formation of individual numbers and specify the percentage of writers that use a particular form of a number (Table 3).

Sixty percent of the 200 participants wrote a "2" with a lower ending loop. Included in this group will be the "2" with a small loop or retrace as the initial stroke at the top of the curve and the "2" minus the loop or retrace. The use of both the "2" with an initial retrace or loop at the top of the curve and the "2" minus this movement was observed in 20% of the writers.

Forty percent wrote a "2" with a horizontal base stroke. The horizontal base stroke "2" was used by thirty eight percent of the 675 participants in Horan and Horan's study (1984). In this study, two different habits concerning baseline alignment of the "2" with a horizontal base stroke were observed. Seventeen percent of the writers wrote the "2" above the baseline with a noticeable back slant. Twenty-three percent aligned the "2" on the baseline with the slant consistent with the surrounding numbers.

Twenty-two percent of the 200 participants in this study wrote both a "2" with a lower loop and a "2" with the horizontal stroke.

Internal Consistency			Example
Feature	Numerals	Percentage	
lower loop	3 & 5	25	
	3 not 5	5	
	5 not 3	2	
initial loop/retrace	2, 3 & 7	15	

Table 2

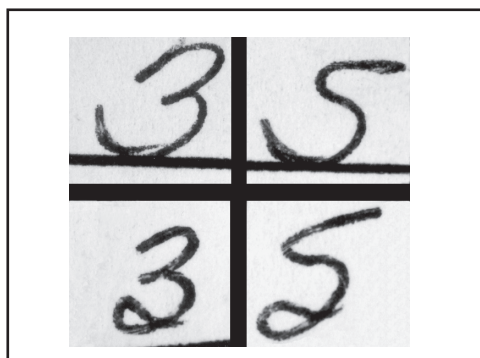


Figure 3. Twenty-five percent of the participants used an open loop or a retrace stroke inside the lower bowl of both the "3" and the "5."

Nine percent of the participants in this study wrote a "4" with the body in a triangular or "tent-shaped" form. Another eleven percent wrote a "4" with a loop or retrace in the left corner of the body. Horan and Horan revealed 6.6% of their participants wrote a triangular form "4" and later research conducted by Horton involving 580 participants revealed 5.6% wrote the triangular form of the "4" (1996).

Twenty-three percent of the 200 participants wrote a single stroke "5." Horton's research yielded 17% use of the single stroke "5". Seven percent of the participants' exemplars contained both a single stroke and a two-stroke "5." Five percent of the 200 participants began their single stroke "5" with a retrace on the top horizontal stroke (Fig. 4). Eight percent had a "dip" in the top horizontal stroke of the single stroke "5."

Of the 200 participants, ten percent of the participants wrote a crossbar "7." Two percent of their exemplars contained both the crossbar "7" and the English-American "7." Earlier research by Horton revealed 18% of his participants made a "Euro" or crossbar "7." Horton suggested the higher incidence of the crossbar "7" in his study may be due to the fact that his participants were all military personnel who, at one time, had been stationed in Europe.

The exemplars from the participants in this study yielded five different forms of the number "8." Sixty-six percent made the number "8" with the initial stroke beginning in the upper right corner with the stroke moving downward in a counter-clockwise motion (the "S" shape) and ending in the upper right corner. Eleven percent made the number "8" with the initial stroke beginning in the upper left corner with the stroke moving downward in a counter-clockwise motion (the "S" shape) and ending in the upper left corner. Six percent made the number "8" with the stroke in the upper left corner and the stroke moving clockwise and ending in the upper left corner. Two percent made the number "8" with the stroke beginning in the upper right corner and moving downward in a clockwise motion forming the bottom bowl and then continuing upward making a sharp angled right turn to end next to the initial stroke. The top of this style of "8" is angular and flat (Fig. 5). Fourteen percent of the writers made the number "8" with two attached ovals (snowman "8"). One writer, or less than 1%, made the number "8" with the initial stroke on the baseline in the lower left corner and the stroke movement resembling a cursive capital "S" (Fig. 6).

Of the 200 participants, one writer (less than 1%) used three forms of the number "8" which included the snowman "8," the "8" with the initial stroke in the upper right corner, and the "8" with the initial stroke in the upper left corner (both body formations in the shape of the "S"). One percent used the snowman "8" and the "8" with the initial stroke in the upper left corner with the downward motion clockwise in their exemplars. Eleven percent of the participants used both the "8" with the initial stroke in the upper right corner and the "8" with the initial stroke in the upper left corner (both body formations in the shape of the "S"). The exemplars of another eleven percent revealed the use of both the snowman "8" and the "8" with the initial stroke in the upper right corner.

This author observed that participants were consistent in their preference of a one-bar or two-bar dollar sign. Seventy-six percent of the participants in this study used a two-bar dollar sign and sixteen percent used the single bar dollar sign. The remaining 8% did not use a dollar sign on the exemplars. Similarly, Horton's study revealed 77% of his participants used the two-bar dollar sign and 18% used the one-bar dollar sign.

A literature research and review was conducted after the results of this study were compiled to determine if the results found were in agreement with past studies. Regarding individual number formation, the literature research revealed 76% of Horton's participants made their number "8" with an initial stroke at the upper right corner with an "S" formation for the body; 9% for the number "8" with the initial stroke beginning in the upper left corner; 14% made the number "8" as a two-piece (snowman "8"); and, out of 580 participants, he also had one writer that made the number "8" at the baseline in the lower left corner with the stroke movement resembling a cursive capital "S."

Sixty-eight percent of the Horan and Horan research participants made the number "8" at the upper right corner with an "S" formation for the body. Although this study and the Horton study both tallied a 14% usage of the snowman "8," only 4.1% in the Horan and Horan study made the number "8" in the two-piece oval style or snowman "8." The lower percentage reflected in the Horan and Horan study could be due to each study's classification method of number formation. The Horan and Horan study, for example, applied the Ansell and Strach classification system whereas this study did not.

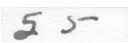
Numeral	Style	Percentage	Habit	Example
2	lower ending loop	60		
	horizontal base stroke	40	17% wrote numeral above baseline w/blackslant	
	combination	22	lower loop and single horizontal stroke	
4	triangular/"tent-shaped" form	9		
	loop/retrace in left corner of body	11		
5	single stroke	23	7% contained both single & two-stroke "5"	
	single stroke w/top horizontal retrace	5	8% contained a "dip" in top horizontal stroke	
7	crossbar	10		
8	initial stroke beginning in upper right corner/downward counterclockwise motion	66	"S" shape	
	initial stroke beginning in upper left corner/downward counterclockwise motion	11	"S" shape	
	initial stroke beginning in upper left corner/downward clockwise motion, end at upper left	6		
	initial stroke beginning in upper right corner, then moving downward clockwise motion, forming bottom bowl with a lower left loop moving the stroke upward that makes a sharp angle turn to end in upper right corner	2	angular and flat	
	two attached ovals	14	"snowman"	
	initial stroke on the baseline in lower left corner; stroke movement resembles capital cursive "S"	<1		

Table 3

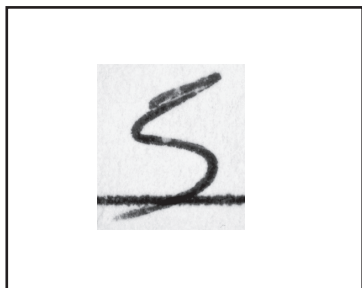


Figure 4. Five percent of the participants began their single stroke "5" with a retrace stroke on the top horizontal stroke.

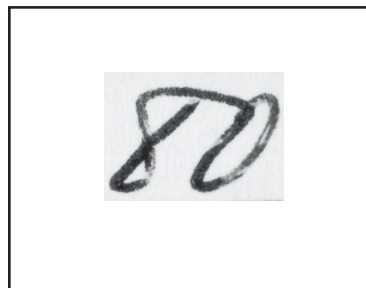


Figure 5. Two percent of the participants began their single stroke "5" with a retrace stroke on the top horizontal stroke.



Figure 6. Out of 200 participants, one writer executed the "8" with the initial stroke in the lower left corner at the baseline and moves upward in a counter-clockwise motion to form the body in the shape of a cursive capital "S."

Discussion

The range of a writer's natural variation in numbers is dependent on whether the particular writer is an intermittent or daily writer of numbers. An intermittent writer of numbers will have a slightly greater range of variation in number form as the writing of numbers is less automatic. Conversely, an accountant, bookkeeper or bank teller develops automatic fixed habits in numbers through the repetition of conducting their daily tasks (Conway, 1959). Part of a writer's variation may include the use of two (2) or more forms of a number. Through her research of one hundred participants, Giles found over 48% used two or more

forms of the "6," 55% used two forms of the "2" and 43% used two forms of the "9." Variation in the use of more than one number form was observed in this study. Out of 200 participants, 46% used two forms of the number "2," 38% used two forms of the "9," and 32% used two forms of the "7."

Though numbers tend to depart from the copybook style, the individual characteristics are influenced by formal training. The conventional forms of numbers are modified greatly by different writers, and combinations of these various modifications will often point very conclusively to a particular writer (Osborn, 1929). In this study and the Giles study, different forms of the num-

bers were observed (Table 4). From 200 writers, there were nine different forms of the number "2," seven forms of the numbers "3" and "4," six forms of the number "5," four forms of the number "6," five forms of the numbers "7" and "8" and six forms of the number "9." Giles' research yielded similar results with eight forms of the number "2," six forms of the number "3," the number "4," and the number "5"; three forms of the number "6"; six forms of the number "7"; and five forms of the numbers "8," "9," and "0."

Summary

The combination of habits observed in naturally written numbers aids the document examiner in determining if the suspected writer authored the questioned text of numbers. The significance of

these habits can be assessed by knowing the frequency of occurrence of the habits observed in the questioned and known exemplars.

It is imperative that an adequate amount of known exemplars are submitted in the examination of naturally written numbers. A writer's range of variation in number formation is influenced by his use of numbers; i.e., if he is an intermittent writer of numbers or, by profession, writes numbers on a daily basis. The results of this study and past studies have shown that writers may use two or more forms of the same number. Results of this study also assessed the frequency of occurrence of number formation, the percentage of occurrence with regards to connected numbers, and internal consistency between numbers of similar formation.

Seaman-Kelly Results	
Numeral	No. of Forms
2	9
3	7
4	7
5	6
6	4
7	5
8	5
9	6

Giles Results	
Numeral	No. of Forms
2	8
3	6
4	6
5	6
6	3
7	6
8	5
9	5
0	5

Table 4

References

- Alford, E. (1965). Identification Through Comparison of Numbers, *Identification News*, July, Vol. 15, No. 7, pp.13-14.
- Conway, James V.P. (1959). *Evidential Documents*. Springfield, IL: Charles C. Thomas Publisher, p. 70.
- Dawson, G.A. (1986). Internal Consistency in Handprinting. Presented at ASQDE Conference, Savannah, Georgia.
- Giles, Audrey (1999). Figuring It Out, *Journal of American Society of Questioned Document Examiners*, Vol. 2, No. 2, pp. 62-64.
- Hilton, Ordway (1970). Identification of Numerals, *International Criminal Police Review*, Oct., 241; pp. 245-250.
- Horan, J. and Horan, G. (1984). A Study of Numbers. Presented at the Tenth International Association of Forensic Sciences Meeting, Oxford, England.
- Horton, Richard A. (1996). A Study of the Occurrence of Certain Handwriting Characteristics in a Random Population, *International Journal of Forensic Document Examiners*, Vol. 2., No. 2, pp. 95-102.
- Osborn, Albert S (1929). *Questioned Documents*. Albany, NY: Boyd Printing Company, p. 300.
- Seaman-Kelly, Jan (1999). The Examination of Disguised Numbers, *Journal of Forensic Sciences*, Vol. 44, No. 5, pp. 1027-1028.