

A Statistical Correlation Coefficient To Validate The Effect of Age on Handwriting

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Introduction

Handwriting is a legitimate text created by an individual using a writing instrument which can be a pen or a pencil on any writing surface. When speaking analytically handwriting is an indicator of personality which is clearly depicted by a neurological pattern of the brain [1]. Putting it more simply, human brain produces character due to habit, which is developed over a period of time thus imparting individuality to a person's handwriting. Our brain guides the movement of our hand. With the learning process the skill to master handwriting is developed. But when it comes to analysis it is a very complex trait. It involves a number of studies namely linguistic, cognitive, psychological, perceptual and motor components considering temporal conditions as well.

Traditional methods of forensic investigation regarding handwriting involve quantization of natural individual characteristics [1]. This further enables a scientific/statistical study of the individuality of handwriting thereby allowing comparisons among the samples. Handwriting of an individual is not consistent with respect to individual characteristics. Changes in handwriting may occur due to [2]:

- Variations in geography
- Variations in writing surface and writing instruments
- Intoxication
- Age

On the other hand forensic analysis of individual characteristics is independent of such variations which has been observed and timely reported [3]. The concern of this paper is to highlight the change in handwriting of individuals as they grow old with the aid of forensic analysis of individual characteristics of handwriting. The samples collected are spaced by at least 10 years. The characteristics that have been studied are *proportion* and *inter-word spacing (hiatus)* [4]. The traits have been statistically studied for the production of quantitative data. During the course of this research it was observed that there is a statistical relation between *time elapsed* and *changes observed* in the characteristics of handwriting.

Individual Characteristics

Ever since the onset of field various individual characteristics have been employed by forensic scientists to compare questioned documents [5] several scientists have given their own set of forensically relevant individual characteristics [1]. The set of characteristics that have been considered are:-

1. *Baseline Alignment*- It is the imaginary line on which the written text sits.
2. *Slant* – It is inclination of writing with respect to the baseline. It can either be “forward” i.e. stooping towards right side; or “backward” i.e. stooping towards left side.
3. *Skill*- It is directly proportional to the practice done for writing as a child. High skilled writers have clear and beautiful writing. On the contrary low skill level have a uneven writing with irregular strokes.
4. *Form*- The type of writing style, whether cursive or block letters.
5. *Movement*- Manner of movement of the writing instrument (either a pen or pencil) to form a letter/word.
6. *Proportion*- It is the value obtained with the height of a small letter with a tall letter.
7. *Heights/ Ratios and Proportions*- Comparison or correlation of the height of one letter or letter segment to another letter, usually within the same word or signature.
8. *Pen Lift*- An author often lifts the writing instrument from the writing surface, usually in the midst of a word or a signature.
9. *Loop*- Loops are generally found in cursive handwriting styles. These maybe symmetrical or asymmetrical
10. *Embellishment*- It refers to the corrective after stroke and is usually seen at the beginning of the document but can be found throughout the writing.
11. *Entrance and leaving Strokes*- Also termed as entry and exit strokes of letters or typical words are habitual movements and therefore may serve as identifying characteristics.
12. *Format*- The format of a disputed document may additionally be an identifying characteristic as it depicts the way in which the writer puts common details such as dates, abbreviations, page numbers etc. this may produce individual traits for comparing authors.
13. *Spacing*- The distance between two words (hiatus) or alphabets (in a non cursive script). This varies among individuals.
14. *Case*- The writer’s use upper case or lower case letters in place of each other thereby making case a unique characteristic in handwriting.

Effect of Age

All the activities that a person does are governed by the brain in coordination with the spinal cord and muscles. The brain grows incredibly and tremendously at young age and starts shrinking and degenerating as a person gets older. Handwriting is among the activities that stimulate the better functioning of the brain. When a person is engaged in writing, a number of regions of the brain are involved which work simultaneously to yield the desired result. With the learning process at early age the person acquires knowledge that lasts for a lifetime. With age the brain shrinks and degenerates. As a person hits its later twenties, the neurons start to loosen their proper stimuli and thus reflexes are not generated so quickly [6]. The change is significantly noted in the handwriting of the person which steadily and progressively changes as the person grows. The extent of this change is dependent on different factors, namely skill level, health and the stage of life of the author. Skill level increases as the person grows from infant to young adult, thereafter with lack of practice and irregular writing habits the skill level gradually decreases. Health of the person plays an important role as well. Be it physical health or mental health, the brain activity is slowed down in such cases. The prime focus of the brain is to prepare the body to fight the disease, thus other reflexes are not well coordinated. As age progresses the brain activity falls. For the

reasons mentioned above, the writing standards obtained for comparison must be comparable and contemporary. In old age the writing is characterized by either lack of control of the writing instrument or tremors [HH]. The strokes made by the writing instrument tend to be rough and written with immense pressure which breaks the continuity of the line.

Hilton has stated that a signature or writing with tremors exhibits sense of sporadic moments of freedom and fluency. A research was conducted by him on children aged from 6 to 18 years, where he concluded that speed, automation and pressure increases with age and variability on the other hand decreases.

Age significantly affects sensory processing and handwriting pressure along with temporal and spatial measures.

Works conducted by Dixon et.al. and Hackel et.al showed that speed decreases with increasing age.(Dixon, Kursman and Friesen, 1993; Hackel, Wolfe, Bang and Canfield 1992).

Experimental Setup

The experiment conducted analyzed handwriting samples from 20 subjects, above 18 years of age. The gap maintained between the ages of individuals was 10-15 years. After collection of the samples, individual characteristics were observed in the samples. The differences and change in the degree, age gap was noted down. The samples were analyzed as per the standards. Hiatus (inter-word spacing) and proportion were considered.

Observation

The samples were analyzed for the characteristics namely hiatus and proportion. Reading was taken in a random manner and the mean of each sample which had at least 30 readings was calculated. To put the theory in mathematical coefficient form standard deviation and variation was further calculated. The readings that came out were in a format that showed a similar pattern. The increase in fluctuations in hiatus and proportion was periodic and occurred at precise and regular interval for every individual separately. Thus the change observed was peculiar for every individual.

Calculations:

(a). Calculation of obtaining mean and standard deviation for hiatus -

Sample No.	Delta	(X- \bar{x})	(X- \bar{x}) ²
01	0.1	0	0
02	0.1	0	0
03	0	0.1	0.01
04	0.1	0	0

05	0.2	0.1	0.01
06	0.1	0	0
07	0	0.1	0.01
08	0.1	0	0
09	0.2	0.1	0.01
10	0.1	0	0
11	0.2	0.1	0.01
12	0.2	0.1	0.01
13	0.1	0	0
14	0.2	0.1	0.01
15	0.1	0	0
16	0.2	0.1	0.01
17	0.2	0.1	0.01
18	0.1	0	0
19	-0.4	-0.5	0.25
20	0.1	0	0
n=20		Total=	0.34

Here “n” is the total number of samples taken.

Mean= Sum of all variables/ total no. of observation (of the entire population taken).

Delta being the mean of a particular sample.

Thus the mean is = $0.1+0.1+0.1+\dots\dots\dots 01/20 = 0.1$.

Mode= Most observed frequency of data.

The mode is 0.1.

$$s = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}$$

Here sum of (X-x) is 0.34, and n = 20

Therefore, variance = 0.017

Standard deviation = 0.1

(b.) Calculation for obtaining mean and standard deviation of the proportion -

Sample No.	Delta	(X- \bar{x})	(X- \bar{x}) ²
01	0.5	0.1	0.01
02	0.4	0	0
03	0.4	0	0
04	0.9	0.5	0.25
05	0.4	0	0
06	0.5	0.1	0.01
07	-0.02	-0.6	0.36
08	0	-0.4	0.16
09	0.2	-0.2	0.04
10	0.5	0.1	0.01
11	0.6	0.2	0.04
12	0.6	0.2	0.04
13	0.2	-0.2	0.04
14	0.2	-0.2	0.04
	0.4	0	0

Mode	15			= 0.4
	16	0.8	-0.4	0.16
	17	0.3	-0.1	0.01
	18	0.1	-0.3	0.09
	19	0.3	-0.1	0.01
	20	0.4	0	0
	N=20		Total=	1.11

$$s = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}$$

Here, Mean is 0.4.

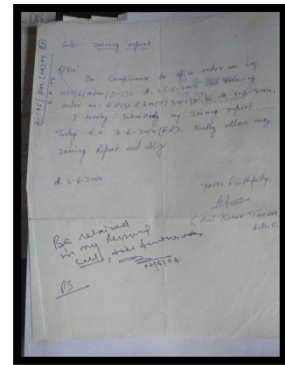
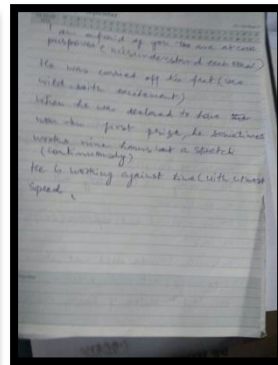
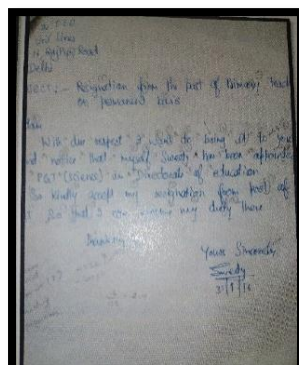
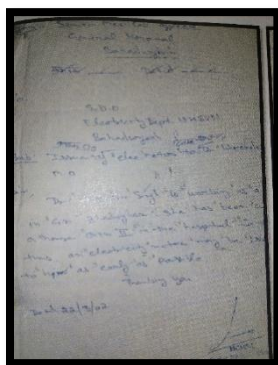
Mode being 0.4.

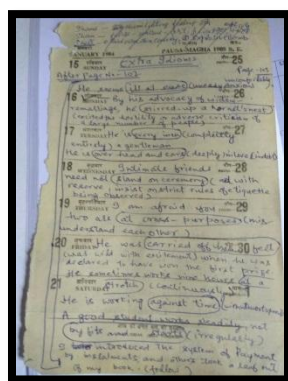
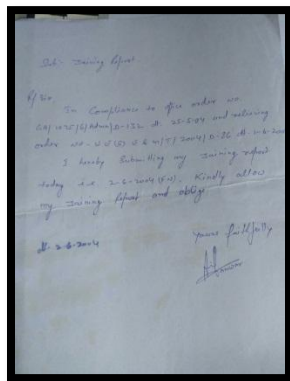
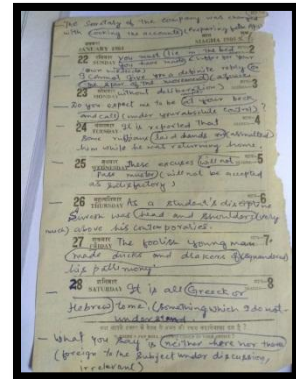
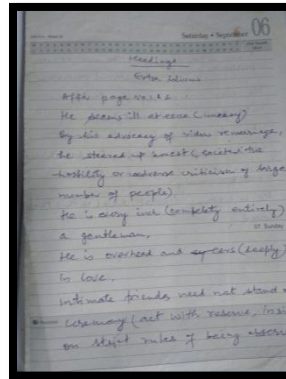
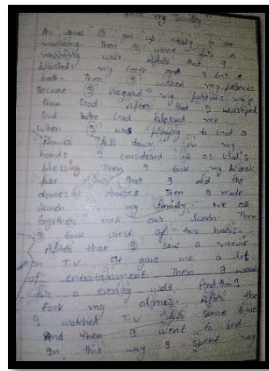
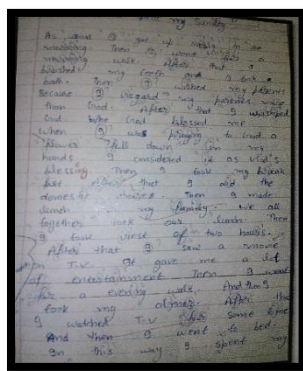
Sum of (X-x) = 1.11

Total no. of obs. (n) = 20

Variance = 0.06

Standard deviation = 0.2





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