

A Review of Handwriting Characteristics Analysis on Various Surfaces: Implications for Forensic Document Examination

Snehalata Shenoy*, Harshita Shekhawat and Anshuman V Ramani

Department of Forensic Science, Vivekananda Global University, Jaipur, India

Abstract

Modern handwriting research has concentrated on skilled performance, child development, a typical development, the efficiency of different letter shapes, teaching methods and the creation and assessment of assessment tools. Due to the potential for unfamiliar surfaces to alter or distort the victim's natural handwriting, the investigation may have run into difficulties. The original handwriting modification called for the use of more advanced analytical methods and in-depth investigation. In this study, forensic exams in such situations are the main topic and their results and success rates are highlighted. The study specifically looks at how utilizing various writing utensils affects handwriting samples discovered on unique and atypical surfaces. The research intends to provide light on the usefulness and dependability of forensic handwriting analysis in situations when the writing medium's surface makes precise identification and interpretation difficult.

Keywords: Handwriting • Analysis • Surfaces • Handwriting characteristics

Introduction

In learning to write, children need to develop enough fluency so that the mechanics of producing text do not interfere with the process of composing. Having to allocate considerable attention to the mechanical demands of handwriting, for instance, may lead a writer to forget already developed intentions and plans or disrupt planning about the next unit of text to be written. Difficulty with learning how to write quickly and legibly can also effect how long it takes students to complete written assignments, their facility at taking notes during lectures, how frequently they write and their perceptions of their own writing capabilities. Although it is difficult to disentangle the factors responsible for developmental changes in handwriting, natural tendencies, culture and education undoubtedly influence the process. The interplay of these factors can be readily observed in studies on the writing development of young children [1].

According to Graham, Berninger, Weintraub and Schafer, the ability to write by hand enhances classroom involvement and serves as a crucial source of self-esteem in youngsters. It is a difficult ability that is sometimes referred to as "language by hand", reflecting the difficult integration of cognitive and motor processes that underlie the activity. As a result, developing good handwriting takes time. Correct letter formation, including size and shape, is first taught in school, then enunciation speed and fluency are introduced later.

As the number of words produced per minute has been found to predict compositional quality in both typically developing children, the development of handwriting speed in particular plays an important role in the overall task of writing [2].

Forensic analysis of handwriting found on unusual surfaces presents a challenging task for investigators due to the distinctive nature of each individual's handwriting, which can vary significantly depending on the writing surface. This variation poses a considerable obstacle in accurately identifying and attributing the authorship of the handwriting. Furthermore, criminals often employ deceptive practices by deliberately forging or altering handwriting evidence, thereby compounding the complexity of the analysis. The investigation of handwriting is a systematic process governed by well-defined rules and steps for analysis. Forensic professionals follow a structured approach to ensure accuracy and reliability in their assessments. The individuality is analysed by letter formation, slant, spacing and proportions. Subsequently, experts delve deeper into the individual elements of the handwriting, meticulously scrutinizing each letter, stroke and connecting feature. They look for distinctive traits, such as loop shapes, the presence of serif or sans-serif details and unique flourishes that can serve as identifying markers [3].

In challenging scenarios like these, handwriting analysis becomes the investigator's most promising avenue for identifying the culprit. Despite the difficulties posed by variations in handwriting on

*Address for Correspondence: Snehalata Shenoy, Department of Forensic Science, Vivekananda Global University, Jaipur, India; E-mail: udipisneha@gmail.com

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unusual surfaces, advancements in analytical procedures designed for handwriting identification have helped forensic professionals navigate these obstacles. These improved techniques have proven invaluable in unraveling the intricate layers of a case and extracting evidentiary value from the handwriting.

Literature Review

Qamar et al, from their study it was found that distinctiveness of a person's handwriting makes it a trustworthy method to determine who wrote a piece of writing, particularly when the writing is discovered on unusual surfaces. Handwriting analyzers can determine who wrote a piece of writing by analysing certain aspects of the author's handwriting, such as slant, relative size, alignment and spacing. This procedure necessitates a deep comprehension of a person's handwriting characteristics and an all-encompassing method of examination. Investigators can establish a certain identification of the writer of the writing by contrasting the handwriting traits of a sample located on an atypical surface with a control sample or recognised handwriting [4].

Joshi and Garg, showed in their study that a group of medico-legal and document examiners were able to utilise techniques to establish the authorship of a suicide note written on an atypical surface. When compared to the deceased's provided Hindi writings, which were verified as authentic, the questioned writings discovered on the deceased's thigh underwent scientific analysis. Comparing the two groups of papers reveals common traits in both the general and individual writing styles. Their examination concentrated on formation of different letters and their combinations, such as their unique or accustomed method of execution, distinctive stroke movement, location and direction of letter beginnings, relative shape and size of medial loops, oval curves and various vowel signs placed over the letters. Examining the handwriting on the corpse's thigh proved that they were really those of the deceased, according to their findings [5].

Kelly focuses on a murder investigation using a shattered yellow balloon discovered in the car of the defendant. The study examines the difficulties associated with recognising teens handwriting, examining writing done using felt-tipped pens and taking into consideration distortions brought on by unnatural writing surfaces, improper writing postures and emotional situations. Through balloon experiments, it was discovered that the writing on the balloon belonged to the killed girl. In court, the matter was successfully pursued.

Fernandes and Lima, conducted a study that Alzheimer's illness has an impact on how signatures are executed, leading to decreased legibility, tremors, poor line quality, uneven spacing, an irregularly shaped baseline and increased fluctuation in the baseline's direction. FDEs should use caution when interpreting these changes since they may be frequent in individuals with more serious cognitive problems. Getting earlier and contemporaneous signatures may aid FDEs in determining if the changes are the result of simulations or the course of the illness. To reliably capture velocity and pressure patterns and to comprehend motor decline in AD patients, more study including a larger sample of patients and kinematic investigations are required.

Demirci et al, wrote a paper which talks about suicide notes which was found on two victims on the forehead and leg, including their ubiquity and importance in shedding light on the factors that suicidal

victims take into account before committing the deadly deed. Most suicides do not have suicide notes and their incidence has been estimated to range from 5% to 43%. Suicide notes are frequently written just before the suicide act and include specific details on suicide victims. Suicide notes can be sent on a variety of materials and over a variety of channels, including face-to-face interactions, phone calls, text messages and internet use. The writers claim that the text is the first to detail two distinct incidents of suicide notes found on the bodies of victims. A university graduate who had donkey scrawled on his forehead and a woman who committed suicide after her husband physically abused her, according to a letter she left on her leg. The authors speculate that the victims may have done so to make sure that their message would be communicated to their loved ones, the police and the judge and that the goal of writing a suicide note on the body varies from that of putting a letter on paper. The article also mentions that statistics show no statistically significant differences between suicide victims who write suicide notes and those who do not in terms of things like gender, age, family status, access to mental care, reason for suicide or technique [6].

Gerth et al, compared writing on paper vs. writing on a tablet to explore the impact of writing surfaces on graphomotor execution. Due to the tablet's decreased friction, all groups-including seasoned writers-exhibited a higher writing pace. However, in activities requiring visual and graphomotor control, the two writing surfaces had varying effects on non-writers, novice writers and seasoned writers. According to the study, it may not be wise to use tablets in schools to help students learn to write since doing so would create an extra difficulty that would likely delay learning to write and make students more frustrated. The research also advises against just digitising paper-and-pencil exam versions since there can be task-dependency and changes in task-demands brought on by the novel and smoother digital format on the surface of a tablet.

Desai and Kalyan, from their study it was found that writing is learned by the deliberate repetition of a model system, which is gradually personalised by numerous elements such as creative talent, physical control and exposure to other people's writing. This leads to the development of a unique writing style throughout childhood and youth. This essay explained about how to identify classes and specific characters in handwriting and signatures, as well as how to spot modifications and forgeries. The skills needed to recognise and distinguish between authentic and faked handwriting are held by forensic handwriting examiners [7].

Cadola et al, conducted a study to establish whether or not spray paint wall inscriptions may be compared using traditional reference materials. 27 volunteer samples were examined and compared visually. According to the findings, letter style and structure were the only consistent writing traits among participants. Between samples of conventional and spray paint, differences in form, connections, spacing, slant, size and proportions were noted. The research advises utilising comparison samples that were written under comparable circumstances to the item in issue and admits the possibility of an emotional state's impact on variances in writing traits. Alamargot and Morin, conducted a study to determine if students who had or hadn't yet learned handwriting motor programmes would respond differently to writing on a digital tablet with a plastic-tipped pen. According to the findings, younger pupils had problems calculating segment trajectories, whereas older students had less

control over muscle correction. This shows that while introducing digital writing technology in the classroom, teachers should take their students' age and developmental stage into account. The study emphasises the value of comprehending the fundamental motor mechanisms underpinning handwriting and the possible effects of new technology on these mechanisms. The findings give significant factors for educators and parents to take into account and vital information on how digital writing devices affect the development of handwriting [8].

Jasuja et al, compared in their study that the handwriting of typical pen and paper writings to writings made on vertical surfaces using spray paint. Letter size changes, paint bleed and masking of delicate details were all noted in spray paint handwriting. The letter spacing and slant, however, remained standard for writing. In spray paint writings, determining the writer's qualities was less accurate based on the relative sizes and placement of the letters. In both handwriting done with conventional ink and spray paint, the letter "o" 's closing position and the dot above the letter "j" stayed the same. These intrinsic variances in spray paint inscriptions should be known by forensic document examiners so they can differentiate between genuine variations and changes that might be signs of fabrication.

Tarannum et al, their study explores the difficulties forensic document examiners encounter when attempting to identify the author of suicide notes that have been written on unusual surfaces using unusual writing implements. The assessment highlights how crucial it is to practise and investigate new avenues for locating and verifying the true author of such papers. The article advises that when comparing atypical writing, both class and individual handwriting traits should be thoroughly assessed.

Upadhyay et al, from their study they emphasises that current study measured slope, loop, angle, baseline, strokes and other characteristics to examine natural variations in signatures on various surfaces. It was determined that the surface had no effect on how the hand moved, however there were substantial variations in signature

size, with lap surfaces displaying the greatest range. Depending on the surface, alignment, pen pause and lift, pressure and other elements displayed small differences. Surface changes also had a little impact on abbreviations, commencing words, meaningless markings, retouching of strokes and spacing [9].

Kapoor et al, from their study it was found that how ageing affects the handwriting of seasoned writers and how that naturally varies with time. When 50 people between the ages of 30 and 55 were investigated, it was discovered that while the features themselves remained more or less constant over time, the range of natural variation changed steadily over time. Nineteen authors' natural variation ranges changed after a ten-year break, although for the most part, this had little impact on how their handwriting looked.

Davis determine the authorship of questioned documents using forensic handwriting analysis, which frequently involves claims of fabrication or deception. Sample writing is gathered from putative writers and consists of writing that was generated on request for the examination as well as writing that naturally occurs for control reasons. Request samples can be camouflaged to make them harder to identify, but you can also edit its content to make it more similar to the text under scrutiny. Letter-by-letter comparison is necessary for handwriting analysis and the validity of the sample writing is essential because any identification is based on comparison with the sample.

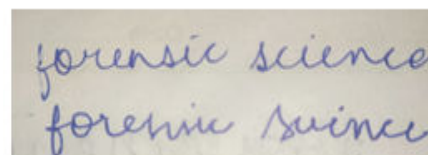
Discussion

Various handwriting characteristics

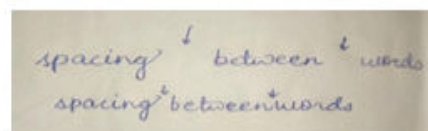
According to Hilton, unique handwriting traits, which are more or less exclusive to a particular writer, provide the basis of identity. Any literary character, any literary work or any writing habit may be altered and personalised by many authors in a wide range of ways and to differing degrees and the writing uniqueness of any one writer is made up of all these typical and unusual traits and behaviours. Table 1 shows the pictorial representation of various handwriting characteristics [10].

Pictorial representation

1 Line quality



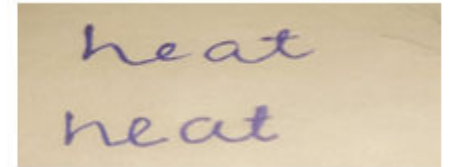
2 Word and letter spacing



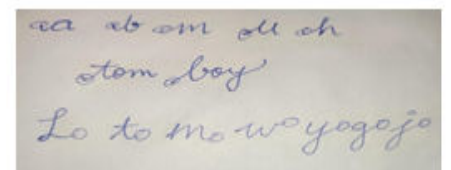
3 Size consistency



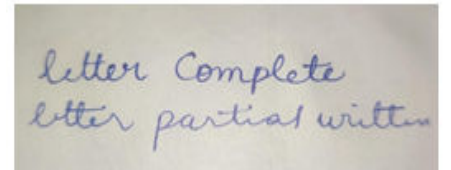
4 Pen lifts



5 Connecting strokes



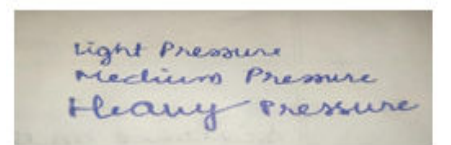
6 Letters complete



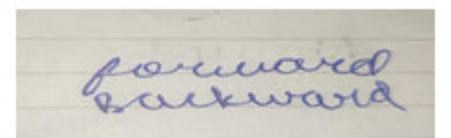
7 Cursive and printed letters



8 Pen pressure



9 Slant



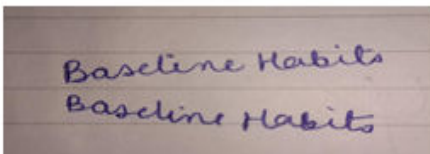

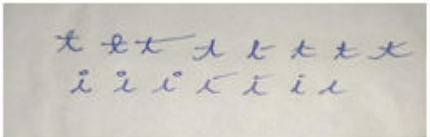
10	Baseline habits	
11	Flourishes and embellishments	
12	Diacritic placements	

Table 1. The pictorial representation of various handwriting characteristics.

Pen lift: Writing the letters of a word normally doesn't pause for skilled and experienced writers. When illiterate people write and find it difficult to write, pen pauses are normal. Despite having the identical reasons for pausing, a forger's pen pause differs from an illiterate person's. In a counterfeit, the pen pauses at the beginning, end, decoration at a challenging formation and connectives.

Slant: This is the writing angle, which can be either forward or backward. One of the most ingrained writing habits is the slant, which under certain circumstances assumes a substantial significance. A small tilt in two lengthy writings might be used to identify the authors of the works. While a noticeable discrepancy might be the product of deliberate deception.

Movement: Writing is performed by moving the fingers, wrist, entire arm or a combination of some of these. A pen moves to produce a letter; this is called movement. This can make it easier to tell how the forms vary. The same two letters can be formed in multiple ways.

Loops: Together, loops and curved strokes create an oval or circle. It is the closed oblong curve of the letter, such as the top or lower portions of the letters 'l' or 'h' or 'y' or 'g'.

Alignment: The foundation of writing in roman scripts is alignment. The bottom line is the basic line in English. The words and letters are arranged on an imagined or real line. Alignment is the relationship between letters in words, a signature or a written line with this real or hypothetical baseline. The alignment might be straight, wavy, uneven, irregular, rising or decreasing. T crossing and I dot-the t-crossing and the i-dot are two of the most obvious strokes that reveal the forger [11].

Spacing: The space between letters in words, between words in sentences and between two lines is known as spacing. When contested and model signatures are placed on each other, spacing is

a key feature in tracked forgeries. However, in traced forgeries, the mathematical spacing and size of the alphabets typically remain the same. Spacing might be average, narrow or broad.

Strokes: These traits, which appear in the early or last writing of handwriting, are likely the least obvious and hardest for forgers to imitate. The final strokes are known as spurs. The examiner will receive enlightening evidence from the methodical comparison of each of these strokes.

Skill: A person's ability to write depends on his or her initial instruction, prior writing experience and emotional and intellectual make-up. He cannot make things better. The writing of a person with high competence cannot be imitated by someone with lesser skill. Thus, it would be simple to rule him out as a suspect [12].

Rhythm: Only those with extensive writing experience and education can write with rhythm. Writing flow, proper line quality, punctuation and appropriate letter and figure construction all serve as indicators of rhythm. It cannot be copied since it is the result of writing and reading experience.

Pen pressure: The fingers' application of force or pressure when writing. It is an unintentional action. Some people apply pressure to specific words or letters. The paper has indentations from the intense pressure that was applied to it. Those who write under a lot of strain write slowly. Usually, illiterate people use a lot of pressure when writing.

Pen lifts: When specific letter forms are encountered, some writers raise their pens. For instance, some writers raise their pen to add a dot, a cross or to finish an incomplete letter. Pen lifts in the questioned signatures suggest fraud when the authentic signature doesn't regularly have any.

Hesitation: In the forgery, the starting and ending strokes exhibit hesitations through tremors of a lack of firmness. The forger hesitates during the initial strokes because he is unsure of his ability to do the task effectively or not. He worries whether or not he was successful

in forging the signature in the closing stroke. These strokes are really made a little more freely than the rest of the text.

Factors that influence handwriting

There are a number of factors that might affect how well someone's handwriting matures. Once handwriting has been established, writing process factors can also affect and alter an adult's handwriting. There are several factors that might affect handwriting in unpredictable situations. People have written on walls, windows, mirrors and furniture using peculiar writing implements. Figure 1 shows the various factors affecting the handwriting characteristic [13].

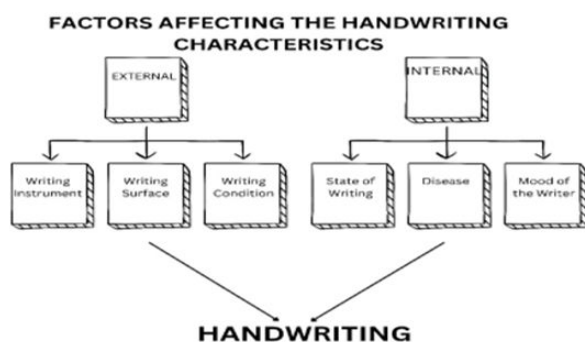


Figure 1. The various factor that affects the handwriting characteristics

Writing surface

A person's handwriting can be significantly influenced by the writing surface. The writing surface can impact handwriting in the following ways, for example:

Texture: Uneven strokes and jagged lines might result from writing on a surface that is rough or bumpy because the pen or pencil may catch or skip. On the other hand, writing evenly and legibly may be made simpler with a smooth writing surface.

Size: The writing surface's dimensions might also have an impact on handwriting. Text on a small surface, like a sticky note, might result in text that is crowded and hard to read. Writing on a bigger surface, such a whiteboard, can result in writing that is larger and easier to read [14].

Stability: It might be challenging to write cleanly and legibly on a shaky or unsteady writing surface. The stability required for legible and even handwriting can be provided by a stable writing surface, such as a desk or table.

Lighting: The amount of light present in the workspace might have an impact on handwriting. Uneven and illegible writing can result from poor illumination, which can make it difficult to see what is being written.

Ink absorption: The writing's appearance can be impacted by the writing surface's capacity to absorb ink. For instance, writing on porous paper might result in ink bleeding or feathering, which causes the writing to seem fuzzy or indistinct.

Overall, writing clearly and legibly may be made simpler by a writing surface that is smooth, solid and the right size.

Writing instrument

The writing tool a person uses may definitely have an impact on how their handwriting looks, as different writing instruments can have varied impacts. The following are some effects that the writing instrument may have on a person's handwriting:

Pen vs. pencil: Writing with a pen results in lines that are fluid, smooth and consistent. In contrast, a pencil may make lines that vary in thickness based on the amount of pressure used. Rollerball pens have the potential to generate thicker, more consistent lines than ballpoint pens do. Lines drawn with fountain pens can be extremely thick or depending on the writer's talent and the pen's nib type, very thin.

Grip: A person's writing style can also be influenced by how they hold a pen or pencil. Some folks could have a tighter hold on the pen, which would produce a harder, more angular character. Others could write with a pen held looser, producing a script that flows more freely [15].

Comfort: The writing instrument's comfort can have an effect on handwriting. It's possible for the writing to become more crowded or uneven if a pen or pencil is hard to grasp.

Writing posture

A person's posture may have a big effect on their handwriting. The following are some ways that posture might impact writing:

Position of the arm and hand: The position of the arm and hand can have an impact on handwriting. Lack of support for the arm can cause tiredness and strain, which can impair the quality of one's handwriting. Similar to this, improper hand positioning on the paper can result in cramped handwriting that is difficult to read.

Muscular strain: Bad posture can lead to neck, shoulder and back muscular strain, which can impair handwriting. Hand shaking due to tense muscles can make writing look sloppy and be hard to read.

Breathing: Poor posture can also influence one's ability to breathe, which can impact one's ability to write. If a slouched posture can cause shallow breathing, which can reduce the amount of oxygen reaching the brain. Both focus and writing quality may be impacted by this.

Conclusion

Different variables impact the diversity in handwriting on diverse surfaces, which is a complicated phenomenon. The look and legibility of handwriting are influenced by the texture, smoothness, absorbency and kind of writing tool used, as well as the surface. Additionally, changes in handwriting on various surfaces may also be caused by individual differences in writing technique, grip and pressure. Despite these difficulties, a lot of people may practise and gain expertise to adjust their handwriting to various surfaces and situations. To increase the consistency and readability of handwriting, try different writing implements, changing up your grip and utilising the right writing surfaces.

References

1. Kapoor, TS, M Kapoor and GP Sharma. "Study of the Form and Extent of Natural Variation in Genuine Writings with Age." *J Foren Sci Soc* 25 (1985): 371-375.
2. Markham, Lynda R. "Influences of Handwriting Quality on Teacher Evaluation of Written Work." *Am Educ Res J* 13 (1976): 277-283.
3. Thomassen, Arnold JWM and Hans-Leo Teulings. "Constancy in Stationary and Progressive Handwriting." *Acta Psychol* 54 (1983): 179-196.
4. Graham, Steve, Virginia Berninger, Naomi Weintraub and William Schafer. "Development of Handwriting Speed and Legibility in Grades 1-9." *J Educ Res* 92 (1998): 42-52.
5. Berninger, Virginia W, Robert D and Abbott. "Writing and Reading: Connections Between Language by Hand and Language by Eye." *J Learn Disabil* 35 (2002): 39-56.
6. van Galen, Gerard P. "Handwriting: Issues for a Psychomotor Theory." *Hum Mov Sci* 10 (1991): 165-191.
7. Prunty, Mellissa and Anna L Barnett. "Understanding Handwriting Difficulties: A Comparison Of Children With And Without Motor Impairment." *Develop Dysgraph* (2019): 141-154.
8. Graham, Steve, Virginia W Berninger and Robert D. "Role of Mechanics in Composing of Elementary School Students: A New Methodological Approach." *J Educ Psychol* 89 (1997): 170.
9. Prunty, Mellissa M, Anna L Barnett and Kate Wilmot. "The Impact of Handwriting Difficulties on Compositional Quality in Children with Developmental Coordination Disorder." *Br J Occup Ther* 79 (2016): 591-597.
10. Sumner, Emma, Vincent Connelly and Anna L Barnett. "The Influence of Spelling Ability on Handwriting Production: Children with and without Dyslexia." *J Exp Psychol Learn Mem Cogn* 40 (2014): 1441.
11. Willett, Francis R, Donald T Avansino and Leigh R, et al. "High-Performance Brain-To-Text Communication via Handwriting." *Nature* 593 (2021): 249-254.
12. He, Qiang, Zhiping Feng, Xue Wang and Yufen Wu, et al. "A Smart Pen Based on Triboelectric Effects for Handwriting Pattern Tracking and Biometric Identification." *ACS Appl Mater Interfaces* 14 (2022): 49295-49302.
13. Chaudhari, Kinjal and Ankit Thakkar. "Survey on Handwriting-Based Personality Trait Identification." *Expert Syst Appl* 124 (2019): 282-308.
14. Baxter, PG. "The Distinction between "Graphology" and "Questioned Document Examination"." *Med Sci Law* 6 (1966): 75-86.
15. Wiley, Robert W and Brenda Rapp. "The Effects of Handwriting Experience on Literacy Learning." *Psych Sci* 32 (2021): 1086-1103.

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