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IP International Journal of Forensic Medicine and Toxicological Sciences

Journal homepage: http://www.ijfmts.com/

Review Article

Review on handwriting examination on unusual surface

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ARTICLE INFO

Article history:
Received 08-11-2023
Accepted 15-12-2023
Available online 19-01-2024

Keywords:
Unconventional Surfaces
Examination
Handwriting
Unusual Surface
Writing Instrument

ABSTRACT

Individuals have a unique handwriting style, which can aid investigators in identifying suspects and perpetrators at a crime scene. A handwriting analysis can also provide information about the crime's circumstances, including its social and physical surroundings. Handwriting investigations use a variety of analytical factors, including pen pressure, line quality, alignment, and the spacing between words and letters, to determine the mode, conditions, and surroundings of the crime. However, the use of atypical surfaces at crime scenes for handwriting evidence may pose a problem to detectives as they may affect the normal handwriting of the victim, requiring more complex analytical instruments and lengthy investigations. This paper analyzes the success rate of forensic investigations and conclusions linked to handwriting analysis, including the impact of various writing implements on non-traditional and unique surfaces.

1. Introduction

The foundation of handwriting analysis is the idea that every person has a distinct writing style. Writing by hand is a learned and intricate perceptual motor skill that requires three separate neuromuscular processes (Huber & Hedrick, 1999). Creating a graphical representation on a surface to communicate a message is the act of handwriting. In order to accomplish this, certain guidelines have to be observed

When joining letters, especially when working with traditional media like paper. Depending on the language and its corresponding scripts, these pairings may also indicate different higher-level linguistic units in different shapes.

A certain region of the brain that also controls language and writing skills is in charge of handwriting (McMahon, 2008). It takes time to acquire the coordination between the arm and hand movements needed for writing, making learning to write a continual and difficult process (Levinson, 2001). A person's ability to write and speak may be affected by any damage to this area of the brain. Evidence in the form of handwritten notes discovered at crime scenes might shed light on the circumstances leading up to the crime. Unusual surfaces like mirrors, tables, windows, skin, plants, and walls may also hold information about the past events. Examining handwriting discovered on peculiar surfaces for forensic purposes is a challenging undertaking for investigators. This is mostly because each person's handwriting pattern varies depending on the surface. Additionally, in an effort to avoid being discovered, criminals frequently alter handwritten evidence. (Tarannum et al 2015).[1] In these situations, identifying the criminal's handwriting would be a crucial assignment for the investigator to pursue. These obstacles may be partially overcome by developments in analytical methods for handwriting identification, which would also assist forensic specialists in dissecting the layers.

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https://doi.org/10.18231/j.ijfmts.2023.028

1.1. Handwriting identification

When utilizing handwriting as evidence in a criminal investigation, a regulated procedure with well-defined processes of analysis and principles is followed. The idea behind handwriting identification is that each person's handwriting is a distinctive characteristic that sets them apart from one another (Held, 2001). A person's handwriting is unchangeable and remains constant throughout their lives.

No two people are exactly alike, and the same cannot be said of two people's handwriting. By carefully examining each handwriting's unique qualities and applying a variety of sophisticated analytical tools, differences in handwriting can be evaluated. The differences between two people's handwriting can be precisely studied because of these analytical methods.[2]

Handwriting analysis is a forensic technique that involves evaluating a document in order to detect and compare the distinctive aspects of a person's handwriting. Handwriting evidence, like fingerprint evidence, is regarded reliable and acceptable in court. A document inspector examines the handwriting in great detail in order to determine both class and individual features.

The broad traits that are present in a collection of handwriting samples are referred to as class characteristics. These could include the kind of writing tool utilized, the size and form of the letters, and the writing style. Contrarily, distinctive qualities are particular to each person and can include letter forms, slant, spacing, and pressure.[3]

The fundamental tenet of handwriting analysis is that no two people write exactly similar. The ability to write by hand is a personal talent that is shaped throughout time by a variety of elements, including education, culture, and personal taste. A document examiner can assess the authenticity of a signature or identify the author of a document by examining the distinctive characteristics of a person's handwriting.

The initial step in handwriting analysis is to look for any evident class characteristics in the paper. This may include the type of paper used, the writing instrument used, and the writing style. The examiner will also search for any intentional attempts to cover up or modify the handwriting, including switching to a new writing tool or trying to write in a different style.

The examiner will proceed to the individual features of the handwriting after determining the class characteristics. This entails a thorough analysis of the handwriting's letters, strokes, and other characteristics. The examiner will pay close attention to particulars including the size and form of individual letters, the distance between words and letters, and the writing's slant.

Document examiners may employ a number of analytical tools and procedures in addition to examining the handwriting's characteristics to improve their analysis. These could include electrostatic detection analysis, which employs static electricity to identify impressions or indentations left on a paper, and spectrum analysis, which examines at the ink used in the handwriting.[4]

In criminal investigations, handwriting evidence is frequently used to identify suspects or connect particular people to a particular crime. For instance, handwriting evidence from a threatening letter addressed to a victim may be examined to determine the author's identity. Evidence of handwriting can also be utilized in legal situations, such will or contract disputes.

Evidence pertaining to handwriting must fulfill specific requirements in order to be allowed into court. The examiner must be qualified to offer an expert opinion on the evidence, and the evidence must be pertinent to the case at hand. Additionally, the examiner must be able to prove that the methods utilized to evaluate the handwriting are trustworthy and supported by science.

Overall, handwriting analysis is an effective forensic technique that can yield important proof in both criminal and civil situations. Document examiners can verify the legitimacy of a signature, identify the author of a document, and give other important information to support legal processes by closely scrutinizing the distinctive qualities of each person's handwriting. To make a compelling case, handwriting analysis should always be utilized in conjunction with other types of evidence because it is not perfect.

The features for the handwriting comparison are as follows:-

1. ***Slant:*** Slant refers to the tilt of the handwriting, which can be either completely vertical or completely horizontal. They are separated into three categories based on the tilt's direction: straight, left, and right handed.
2. ***Size:*** Size does not matter since it is unimportant. The relevance lies in the relative size, not the size of the letters themselves. When someone attempts to copy someone else's handwriting, they must replicate the relative size ratio of the letters, which is simply impossible. However, in the process, the forger doesn't pay attention to the size, slant, or any other aspect of the writing; instead, they only attempt to capture the visual aspect of the text that needs to be replicated.
3. ***Alignment:*** Handwriting alignment can be defined as having letters that are aligned either above, below, or in line with the writing. An illiterate individual has bad alignment, but a skilled one has high alignment. A writer's handwriting alignment characteristic can be used to assess whether they write with appropriate alignment of their letters, words, and lines, or with poor alignment of all three.
4. ***L ine quality:*** line quality can be rated as excellent, medium, or bad. This attribute is also dependent on the

writer's pace and rhythm; the more rhythmic the writer, the higher the caliber of their lines.

5. ***Embezzlement:*** It fundamentally has to do with how the letters are made, or more accurately, how they are decorated. Despite being extremely distinctive, this embellishment is not given much weight by different experts when comparing handwriting since, in their opinion, it is a kind of drawing that is easier to replicate by a forger who uses an artistic approach.
6. ***Pen pause, pen lift and pen pressure:*** The pen's pause, lift, and pressure are entirely hand-operated and rely on the writer's unique style, which involves handling the pen in a highly precise and complex manner.

2. Review of Literature

An essential component of forensic investigations is handwriting analysis. A person's handwriting is a distinctive characteristic that can be used to identify suspects and offenders at a crime scene. Additionally, it can offer insightful information about the crime's circumstances, setting, and social context. A number of analytical factors, including pen pressure, line quality, word and letter spacing, and alignment, are taken into account while analyzing handwriting. These characteristics can provide light on the nature, circumstances, and setting of the crime.

Since no two people write identically, this fact forms the foundation of handwriting analysis. A neuromuscular mechanism is used to learn the personal ability of handwriting. It includes a sophisticated interaction between the hand and arm muscles and the brain. Writing is the process of creating an artificial graphic mark on a surface for the purpose of communication. When writing on traditional surfaces, such as paper, there are predetermined guidelines for assembling letters. Based on the script being employed, different languages may utilize different combinations of letters to express the shapes of higher-level linguistic entities.[5]

Many people still choose to write and capture their personal and factual information, as well as their creativity, in handwritten form, even in the age of software technology that makes it possible for people to do so digitally. Because handwriting can offer a unique window into the writer's mind, it is therefore a useful tool in forensic investigations.

Analyzing handwriting entails determining both individual and class traits. Class characteristics are attributes, such age, gender, and educational background, that are shared by a group of people who fall into a specific category. Individual traits, however, are specific to each person and serve as a means of positive identification.

Being a highly specialized area, handwriting analysis calls for a great deal of education and expertise. A range of methods are employed by handwriting analysts to examine and contrast handwritten samples. To study the fine print, they could employ specialized tools like magnifying glasses and microscopes. In order to examine the samples and contrast them with known handwriting examples, they could also utilize computer software.[6]

The examination of handwriting samples found on atypical surfaces is one of the challenges in handwriting analysis. Unusual surfaces including skin, walls, and tables can warp or distort the victim's natural handwriting, making it challenging to identify the writer with accuracy. However, handwriting analysts are able to get over these obstacles and correctly identify the writer by using sophisticated analytical procedures and specialized equipment.

To sum up, handwriting analysis is an essential component of forensic examinations. A person's handwriting is a distinctive characteristic that can be used to identify suspects and offenders at a crime scene. It can also offer insightful information about the crime's circumstances, setting, and social context. Handwriting analysis calls for much expertise and experience and entails determining both individual and class characteristics. Handwriting analyzers employ sophisticated analytical methods and specialized equipment to reliably identify the writer despite the difficulties presented by unique surfaces.

The association between handwriting speed and written output—measured by the number of words produced in a two-hour exam—was examined in a study involving 66 second-year university students. The findings demonstrated that written output in the longer assessment could not be reliably predicted by a brief handwriting speed test. Students were shown to write noticeably more when preparation time was decreased and particular knowledge was raised. Byard and Health (2007) talked about the characters that have been used to carry out suicidal expectations or endeavors when they come across an alleged suicide note in which the person has stated why they want to end their life or the circumstances that led them to take such actions. Demirici et al. (2009) reported on two suicide death cases in which the victims' suicide notes were found on their bodies. The first suicide case included a 32-year-old man who hanged himself in his own home. When the professionals performed an exterior examination, they noticed that the victim's body had some words written on it with a pen: "HODJA" was on the right side of the chest and "DONKEY" was on the forehead. 'DO NOT" was written on sterna region, and WASH" on the left region and on the both zygomatic regions, some undecipherable handwriting was found. The second suicide instance was a 39-year-old woman. She was a homemaker who committed herself by swallowing an insecticide while experiencing physical abuse from her spouse. The suicide note, scrawled in pen on the woman's left leg, said that she killed herself because she could not bear to be physically abused by her husband and that there was an inheritance dispute between him and her older brother. We looked at a number of variables

that were supposed to affect writing speed, such as pencil grasp, weariness, readability, and writing style. The study discovered that writing style, weariness, and readability had no discernible effects on written output. But only in situations where writing speed was the main objective of the task—like in the three-minute handwriting speed test—was it discovered that the pencil grasp employed affected the amount of writing produced. It was discovered that using a dynamic pencil grasp led to speedier writing in the short term, which makes it useful for jobs like taking notes during lectures. The overall benefit of a dynamic pencil hold in prolonged writing, however, was not clear.[7] The association between written output and self-rated pain in the writing arm was another important study finding. Pupils who reported higher degrees of pain compared to those who ranked in the top third wrote substantially less. It's unclear if this was because these kids were inherently slower writers or if their slower writing was a result of increased discomfort. Overall, the study indicates that while specific knowledge and preparation time can have a major impact on writing productivity, handwriting speed is not necessarily a good indicator of written output. The study also emphasizes the potential benefits of employing a dynamic pencil grasp in specific situations, including taking notes, but issues a warning: don't assume that utilizing this method will always lead to faster writing. Lastly, the study indicates that physical variables that may affect writing productivity, such as pain in the writing arm, might have a major effect on written output and should be considered.

3. Materials and Methods

50 people, 20 women and 30 men, between the ages of 18 and 25, provided writing samples under both typical and unusual writing circumstances so that a comparison could be made between them. To create standard samples, ballpoint pens that are widely available were utilized. Two unusual writing instruments were used: a ball point pen and a marker. Writing surfaces consisted of a mirror and a wall that were easily accessible.

Using a blue ballpoint pen and white A4 paper that was placed on the cardboard, the participants were told to write the words "Pack my box with five dozen jugs of hot water quickly" along with their signatures and the numbers 0–9. Until the end of the sheet, they were instructed to repeat this task.

These samples were regarded as writings that were created in typical situations. They were then instructed to write the identical text with a ballpoint pen and a marker on the floor and mirror, respectively. For comparison's sake, writing samples from each participant were collected under five distinct writing scenarios.

A digital single-lens reflex camera (Nikon D3300) was used to photograph each set of samples. A mirror was positioned across from a clear backdrop to provide a clear image of the writing. The camera and scale were positioned so that they were almost parallel to the writing when the photos were taken.

Table 1: Number of samples

Writing instruments	Writing surfaces			Total
	floor	Mirror	A4	
Ballpoint pen	50	50	-	100
Marker	50	50	-	100
Ballpoint pen	-	-	50	50
Total	100	100	50	250

4. Results

To investigate the impact of unconventional writing tools and surfaces on writing characteristics like line quality, slant, relative height and ratio of letters, alignment, spacing, margins, and letter forms, all writing samples that were gathered using ballpoint pens and markers on the floor and mirror were analyzed and compared with their corresponding writings written under normal circumstances.

The following are the analysis's feature-by-feature results:-

4.1. Line quality

It is a result of a variety of elements, such as rhythm, overwriting or retouching, pen lifts, connections, hesitancy, the characteristics of the beginning and ending strokes, etc.[8]

4.1.1. Rhythm

Table 2 shows that, in comparison to writings written in normal condition, 10% of writing samples of marker-mirror pairs and 16.66% of writing samples of ballpoint pen-mirror pairs showed less rhythm.

Table 2: But there wasn't a single writing sample that lacked perfect rhythm.

Writing instrument/surface	Characteristics (average percentage)		
	Rhythmic	Less rhythmic	Non rhythmic
Ballpoint pen-mirror	82	62.32	0
Ballpoint pen-floor	4.67	14.65	33.35
Marker-mirror	80.33	71.31	-
Marker-floor	2.33	61.31	33.31

Compared to regular writing, the writing samples done on the wall displayed clumsier, autonomous, ill-directed, and disconnected motion. 33.31% of marker-floor writing samples and 20% of ballpoint pen-floor writing samples lacked rhythm.

4.2. Overwriting and retouching

Table 3 makes it clear that the ballpoint-mirror had the lowest percentage of retouching (4.33%), while the marker-floor had the highest percentage (30%). Retouching occurred in 26.33% of ball pen-floor and 17.33% of marker-mirror cases, respectively.

Table 3:

Writing instruments/surface	Characteristics (average percentage)	
	Present	Absent
Ballpoint pen-mirror	4.33	96.66
Ballpoint pen-floor	26.33	74.66
Marker-mirror	17.33	83.66
Marker-floor	30	70

4.2.1. Pen-lifts

Table 4 shows that, in comparison to writings done under normal circumstances, there were more pen-lifts in 92% and 98% of writing samples of ball pen-floor and marker-floor, respectively. But only 10% and 15% of samples, respectively, showed an increase in pen-lifts in the case of the ball pen-mirror and marker-mirror.

Table 4:

Writing instrument/surface	Characteristics (average percentage)	
	Similar	Increased
Ballpoint pen-mirror	90	10
Ballpoint pen-floor	8	92
Marker-mirror	85	15
Marker-floor	2	98

5. Connections

Table 5 shows that, in comparison to writings produced under normal circumstances, there were fewer connections between letters in 92% and 95% of the samples of ball pen-floor and marker-floor. Only 8% and 18% of the samples for the ball pen-mirror and marker-mirror, respectively, showed a decrease in the number of connections between letters.

Table 5:

Writing instruments/surface	Characteristics (average percentage)	
	Similar	Reduced
Ballpoint pen-mirror	92	8
Ballpoint pen-floor	8	92
Marker-mirror	82	18
Marker-floor	5	95

5.1. Initial and terminal strokes

Table 6 makes clear that, depending on the thickness of the writing instrument and writing speed, blunt initial and terminal strokes were present in minimum samples (3.33%) of ball pen-mirror and maximum samples (40%) of marker-mirror. The writings written over the floor showed diminishing initial and terminal strokes, with very little tapered initial and terminal strokes.

Table 6:

Writing instruments/surface	Characteristics (average percentage)		
	Tapered	Blunt	Diminishing
Ballpoint pen-mirror	97	3	0
Ballpoint pen-floor	0	0	100
Marker-mirror	60	40	0
Marker-floor	0	0	100

5.2. Slant

Using an Osborn-designed protractor, the range of slant in each writing sample was quantitatively measured (1929). Table 7 makes it clear that unusual writing instruments and surfaces had an impact on the range of slant. In comparison to writings written under normal circumstances, the range of slant shifted towards the right in 41% and 33% of writing samples of ball pen-floor and marker-floor, respectively. When writing on a mirror, 20% of writing samples showed a slight shift in slant toward the left or backward when using a ballpoint pen or marker, compared to writing done under normal circumstances.

5.3. Letter ratios and relative heights

To ascertain the variation in relative heights and ratios, the letter combinations "Pa" from the word "Parry," "Ro" from the word "Rome," "te" from the word "water," and the word "my" itself were chosen. Using a test plate with a scale of parallel lines spaced 1 mm apart, the height of each letter was measured from head to foot. In every instance, it was found that the writing on the floor and mirror had larger letters than the writings written under normal circumstances. Nevertheless, because the writer used unusual writing instruments and surfaces, the relative heights of the letters were found to remain constant despite the overall size divergence.

5.3.1. Alignment

Four types of alignment are recognized by Huber and Headrick (1999): horizontal, ascending, descending, and irregular.[7] Compared to writings written under normal circumstances, it was found that word and letter alignment with respect to an imaginary base line was altered on mirror surfaces but remained unchanged on floor surfaces.

Table 7:

Writing instruments/surface	Characteristics (average percentage)				
	Similar	Increased towards both sides	Shifted towards left hand side	Shifted towards vertical	Shifted towards right hand side
Ballpoint pen-mirror	30	10	20	20	20
Ballpoint pen-wall	27	19	3	10	41
Marker-mirror	16.67	6.67	20	46.66	10
Marker-wall	27	7	13	20	33

5.3.2. Letter proportion

The spacing was divided into uniform and non-uniform types for qualitative analysis. The larger handwriting on the floor and mirror seemed to have an effect on spacing in that the writer tended to reduce the spacing based on the amount of space available on the surface, which in turn affected the uniformity of spacing at multiple locations, margin.[8] When compared to writings produced under normal circumstances, the majority of the writing samples that were analyzed showed distinct patterns on both the floor and mirror surfaces in all four margins.

5.3.3. Letter forms

A letter form is exactly the spatial arrangement of strokes used to produce a specific character or alphabet. For this study, the formation of the selected letters—"P," "f," "q," and "x"—due to unusual writing instruments and surfaces—was observed, and the results were compared with writings written under normal circumstances. The maximum changes regarding the letter forms were observed in these letters during the preliminary examination.Table 8 clearly shows that in 56.66% of the ball pen-mirror, 66.66% of the ball pen-floor, 60% of the marker-mirror, and the "P" letter form altered in 63.33% of the marker-floor samples. The letter "f" was altered in 10% of the ball pen-mirror samples, 26.66% of the ball pen-floor samples, and 16.66% of the marker-mirror samples.

And 26.66% of marker-floor samples. In 16.66% of ball pen-mirror samples, 20% of ball pen-floor samples, 20% of marker-mirror samples, and 10% of marker-floor samples, the letter form of "q" was altered. The letter "x" underwent changes in 10% of ball pen-mirror samples, 23.33% of ball pen-floor samples, 13.33% of marker-mirror samples, and 23.33% of marker-floor samples.

6. Conclusion

The handwriting of an individual is a distinctive characteristic that provides genuine information and aids any investigative agency in determining the true identity of that person. An investigating officer works with document evidence in many criminal cases, particularly those involving suicide and fraud, where a thorough examination of the handwriting is typically necessary.[9] However, it's not always possible to find a handwriting exemplar on paper or in any other traditional source. Therefore, there is a pressing need for in-depth research in the area of handwriting analysis with regard to writings on unusual surfaces.. Even with advanced tools, it can still take an hour to accurately analyze handwritings that are found as evidence because there is little variation in speed, pressure, stroke, and type of writing instrument.[10]

The study's features, both qualitative and quantitative, were analyzed, and the results indicate that the type of writing instrument and surface used to complete the writing task do affect a number of handwriting features. Nevertheless, there are still a lot of subtle repetitive elements that are habitual and of subliminal origin, far beyond the writer's awareness or practical control.[11,12] Based on their evidential value, the FDE can assess these hidden features with great accuracy and, if deemed appropriate and sufficient in a particular case, form a conclusion regarding the authorship. However, in real-world circumstances, it is observed that establishing authorship of a disputed handwriting may not always be feasible.. This is primarily because there aren't enough identifying characteristics available for a wide range of reasons. These include the limited scope of the writing that is under question, the perpetrator's purposeful deception and disguise to conceal his identity, the inability to read written characters, the lack of comparable letters and letter combinations in the standards that are provided, the low quality of the writing that is under question due to the subject's level of education and skill, the type of writing instrument used, and the surface on which the questioned document was prepared.[13,14] Nevertheless, given the complexity of these issues, it is advised that, to the greatest extent feasible, efforts be made to provide standard material—that is, writing produced under comparable conditions and containing similar combinations and letters—for comparison with the writing in question. It is also important to remember that physical evidence containing contested documents that were produced in such unusual circumstances requires special handling and research. Certain documents, such as writings on floors or

Table 8:

Writing instruments/ surfaces	Characteristics (average percentage)							
	Letter "P"'		Letter "f"		Letter "q"		Letter "x"	
	Similar	Changed	Similar	Changed	Similar	Changed	Similar	Changed
Ballpoint pen-mirror	43.34	56.66	90	10	83.34	16.66	90	10
Ballpoint pen-floor	34.34	66.66	73.34	26.66	80	20	76	24
Marker-mirror	40	60	84	16	80	20	86	14
Marker-floor	36	64	73	27	90	10	76	24

human body parts, obviously cannot be taken straight to the lab. Under such circumstances, providing specialized photos created by a professional document photographer, who accurately captures the originals; if deemed necessary, the document examiner may be granted access to inspect the original writings at the crime scene. [15]

7. Source of Funding

None.

8. Conflict of Interest

None.

References

1. Austin AE, Byard RW. Skin messages in suicide: an unusual occurrence. *J Forensic Legal Med*. 2013;20(6):618–20.
2. Behera C, Rautji R, Krishna K, Kumar A, Gupta S. Suicide note on the palm: three case reports and discussion of medico-legal aspects. *Science and the Law*. 2014;54(2):84–91.
3. Behera C, Swain R, Bhardwaj DN, Millo T. Skin suicide note written in mehndi (henna). *Medico-Legal J*. 2016;84(1):39–41.
4. Cadola L, Cuany S, Weyermann C, Marquis R. Spray paint writings on walls: Is conventional reference material adequate for comparison. *J Am Soc Questioned Documents Examiners*. 2018;21(2):3–11.
5. Demirci S, Dogan KH, Erkol Z, Gunaydin G. Unusual suicide notes written on the body: Two case reports. *Am J Forensic Medi Pathol*. 2009;30(3):276–9.
6. Ellen D, Day S, Davies C. Scientific examination of documents: Methods and techniques. 4th ed. and others, editor. CRC Press; 2006. p. 266.
7. Huber RA, Headrick AM. Writing identification: Facts and fundamentals. 2nd ed. New York: CRC Press; 1999. p. 444.
8. Joshi MC, Garg RK. Examination of writing on an unusual surface in a suicide case: Dead persons do tell tales - conduct a forensic investigation for the cause of humanity and justice. *Probl Forensic Sci*. 2015;101:50–9.
9. Kelly JA. An unusual writing surface and consideration. *J Police Sci Administration*. 1978;6(3):282–5.
10. Levinson J. Questioned documents: A lawyer's handbook. 1st ed. San Diego; San Francisco, New York, London, Boston, Sydney, Tokyo: Academic Press; 2000. p. 250.
11. Osborn AS. Questioned documents. Albany, New York: Boyd Printing Co; 1929. p. 521.
12. Threja M, Saini K, Singh M. A study of the effect of unusual writing instruments and surfaces on handwriting characteristics. *Probl Forensic Sci*. 2019;p. 118.
13. Raju P, Ramesh SV, Arvind H, Baskaran GR, Paul PG. Prevalence of refractive errors in a rural South Indian population. *Invest Ophthalmol Vis Sci*. 2004;45(12):4268–72.
14. Maadeed A, Hassaine S. Automatic Prediction of Age, Gender, and Nationality in Offline Handwriting. *EURASIP J Image Video Processing*. 2014;1:1–10.
15. Dandona L, Dandona R, Naduvilath TJ. Refractive errors in an urban population in Southern India: the Andhra Pradesh Eye Disease Study. *Invest Ophthalmol Vis Sci*. 1999;40(12):2810–8.

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Cite this article: Singh B, Pandey N, Singh S. Review on handwriting examination on unusual surface. *IP Int J Forensic Med Toxicol Sci* 2023;8(4):125-131.