ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 9, Issue, 03, pp.47709-47714, March, 2017

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

VARIATIONS IN SIGNATURE OF A PERSON IN DIFFERENT BODY POSITIONS

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ARTICLE INFO

Article History:
Received 10th December, 2016
Received in revised form
24th January, 2017
Accepted 19th February, 2017
Published online 31st March, 2017

Key words:

Handwriting, Signature,
Body positions,
Personal Identification,
Variations.

ABSTRACT

There has recently been a lack of judicial confidence in the evidence provided by handwriting analysis which has highlighted the need for objective research to be conducted in this area. Typically a person bases his signatures on one template and although no two instances are exactly the same, they are meant to represent the same shape. Because signatures are at least meant to be unique, they can be used for personal identification. This is also how signatures are used in legal cases. The aim of the study was to examine various writing characteristics, whether a different body position influence the signature of the writer. To study the variation in signature at different body posture i.e. sitting, standing and mobile, 3 samples of signature were collected from 100 persons. It has been found that movement of hand shows highly significant difference in all three body positions thereby movements of hand do changes with as position changes and has been concluded that in most of the studied features movement of hand, pen pressure and size of signature show maximum variation with changes in positions.

Citation: Manju Sahu, Moumita Sinha, Kalpana Agrawal and Mitashree Mitra, 2017. "Variations in signature of a person in different body positions", *International Journal of Current Research*, 9, (03), 47709-47714.

INTRODUCTION

In the world of business and literacy most of the transactions take place through document consequently, documents are assuming an increasingly important role in our society. Any matter expressed or described upon any substance by means of letter, figures or marks or by more than one of those means (visible or invisible) intended to be used, for purpose of recording that matter is called a document (Sharma, 1999). Falsification of document is also on the increase. Roughly seventy percentage of the physical evidence is related to disputed documents. Many forms of writing may be encountered as evidence in the course of investigation (Nabar, 2005). An examination of a contested document is a scientific problem and it is no longer confined to comparison of signatures, thumb impressions or writings but it also includes examination of paper, ink, typed matter, printed matter, water mark and all other elements forming documents, (Saxena, 1990). The investigating officer should, therefore, understand the various types of questioned documents, the problems of document examination, the care and preservation of documents and the assistance he can obtain from a document expert (Nabar, 2005). At the same time the investigator should also have the knowledge of handwriting and its various aspects for understanding the nature of writing and writer.

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Handwriting is the written speech of individual. It is a complex motor skill combining sensory, neurological and physiological impulses. The factors such as visual observation, conception of outline, central nervous system pathways and the anatomy and physiology of the bones and muscles of the hand and arm all combine to produce the desired output i.e. handwriting (Hilton, 1982). The skill to imitate the letter formations vary from one person to another and are based on every writer's observation of the image and his or her capability to reproduce that visual perception. One is expertise in the act of handwriting through practice and repetition. Handwriting has unique features and is inimitable to every individual which can be used for personal identification. It is considered as important supportive evidence of information for forensic examination generally in cases such as murder, suicides, kidnapping etc. Handwriting experts as well as forensic expert usually face the difficulties in examination of authenticating the original writer. The position of the surface on which writing takes place can itself rather than that of the writer affect the result (Ellen David, 1997). Questioned document examiners defined variation as imprecision with which the habits of the writer are executed on repeated occasions. Variation in handwriting is the primary principle of handwriting examination (Huber Roy, 1999). As no any two individuals are precisely alike, the handwritings of no two individual are precisely alike in their combination of characteristics. However, due to presence of variation in all handwriting components such as style, slope, slant, alignment,

spacing and pen lift, it serves to personalize and identify writing (Leung et al. 1987).Therefore, it is essential to resolve these primary elements and habits of writing with an accurate range of variation. Previously, motion was used for analyzing the gait patterns. But nowadays, studies were conducted to classify body motion signatures (Williams George, 2010) which mainly encounter the variations observed in signatures due to motion (Fotak, 2011) mention some of the key factors on which a signature depends: physical and psychological state of the person, body position, writing surface and writing material (pen), purpose of signing, environmental factors. Body position of a writer has significant impact on the signature while signing a document, the pressure applied with pen on paper will be different depending on whether a person is sitting, standing or moving. The approach to notice whether a person's body is free from all perspectives or there is any burden on the signing hand is important. Therefore, present study is based on the hypothesis that various parameters of handwriting between male and female subjects and the extent of variation in their writings in different body positions. Very few studies have been conducted for studying impact of various body positions in signature of a writer. In this context, the study was carried out with the hypothesis that different body positions like standing, sitting and movement during signature significantly affects the characteristic features of signature of a writer.

MATERIALS AND METHODS

In the present study 3 samples of signature were collected from 100 persons for the determination of variation within their own signature on different body position i.e. sitting, standing and mobile on the basis of handwriting characteristics. Questionnaire cum schedule was being used for the collection of signature sample. The samples were observed for various parameters to measure the physical characters of signature sample such as size, angles, spacing, alignment and other characteristics to differentiate the variation in signature sample at different body position. The signatures were analyzed through magnifying lens, enlarger, scale and protector. Statistical tools like percentage, t-test, mean, standard deviation and chi-square were used to signify the results of the study.

RESULTS AND DISCUSSION

Since the main objective of the study was to identify whether a different body position significantly affects the signature of writer, therefore we observed the various writing characteristics like Hand Movement, Size of signature, Alignment, Speed, Slanting, Pen Pressure, Spacing, Tremor, Commencement in Signature, Termination in Signature, Simplification of Signature, Combination and separate type of signature, Awkward form of signature, Presence of meaningless marks of each of the respondent's signature are tabulated and discussed as follows. Percentage Distribution of Various Types of Movement of Hand in Signature Variation at Different Body Position was observed (Table 1). It was found that in sitting position while doing the signature maximum respondent's has hand movement type (Fingers + Wrist movement) (84%) while 'Whole Arm movement' type was least in this position (16%). In standing position, while doing the signature respondent's maximum hand movement type was 'Whole Arm movement' (77%) and 'Finger + Wrist movement' type of was least (20%). In mobile position, only 4% signatures of respondents had 'Finger + Wrist movement' type of hand movement and 'Whole Arm movement' was highest in them (77%). It also shows that in sitting position while doing the signature the 'Finger + Arm movement' type of hand movement was almost absent. The higher frequency of Whole Arm Movement in mobile position indicates that writer uses maximum effort for signing during movement. The distribution of range of size of signature at different body positions and their descriptive statistics are shown in Table 2. In sitting position it ranges between 0.9 – 4.3 cm with a mean value of 2.5 cm. In standing position it ranges between 0.7 - 4.5 cm with a mean value of 2.5cm, whereas in mobile position it ranges between 1 – 5.2 cm with mean value of 2.6 cm. The range of variation is more in mobile position followed by standing and sitting position. Statically the size of signature variation is highly significant in two combination of positions (Sitting × Mobile) and (Standing × Mobile). This indicates that the size of signature do not varied in sitting and standing position while variation was only observed in mobile position. A test of significance, t-test was calculated for size of signature in different body positions (Table 16). Statically the size of signature is highly significant in two combination positions between Sitting and Mobile and Standing and Mobile. (Sitting × Standing) $t = 0.5890$, d.f.= 1, p value = 0.5572 , (Sitting × Mobile) $t = 2.2451$, d.f.=1 , p value = 0.0270, (Standing × Mobile) $t = 2.2478$, d.f.= 1 , p value = 0.0268. The percentage distribution of various types of Alignment of signature at different body positions were represented in Table 3. Among all the types of alignment of signature ascending type of alignment frequent in all three positions (i.e. 67% in sitting position, 61% in standing position and 64% in mobile position) followed by even type of alignment of signature in all three positions. The minimum percentage distribution is found in arched alignment of signature in all three positions (i.e. 3% in standing positions, 2% in mobile position and in sitting position this type of alignment is absent). The descending and irregular types of alignment in signature are varied from 1% to 6% in all three positions. The difference in speed within signature at different body positions were depicted in Table 4.

'Fast' difference in speed within signature is found highest in standing position (70%) followed by sitting position (66%) and mobile position (30%). 'Very Fast' difference in speed within signature is observed in mobile position (59%). The percentage distribution of slant of signature at different body positions were shown in Table 5. It was observed that in sitting position while doing the signature respondent's maximum signature are slanted towards left from vertical (41%) ,30% signature were slanted towards right form vertical and 16% signature were vertical, only (13%) signature were slanted towards both directions. Similarly in standing position respondent's maximum signature was slanted towards left from vertical (36%), 33% signature were slanted towards right from vertical, 17% signatures was vertical and minimum signature (14%) were slanted towards both directions. On the other hand in mobile position the respondent's maximum signature were slanted towards right from vertical (36%), 33% signatures were slanted towards left from vertical, 17% signatures were slanted toward both side and minimum signatures (14%) are vertical. Thus variation is found in slant of signature in different positions. The percentage distribution of various types of pen pressure in signature at different body positions were presented in Table 6.

Table 1. Percentage distribution of various types of movement of hand in signature variation at different Body Postures

Body Postures	Types of Movement of Hand						Total
	Fingers + Wrist		Fingers + Arm		Whole Arm		
	No.	%	No.	%	No.	%	
Sitting Posture	84	84%	0	0%	16	16%	100
Standing Posture	20	20%	3	3%	77	77%	100
Mobile Posture	4	4%	19	19%	77	77%	100

Table 2. Statistical variables for size of signature at different body postures (n=100)

Statistical Variables (cm)	Different Body Postures		
	Sitting Posture	Standing Posture	Mobile Posture
Mean	2.5	2.5	2.6
SD	0.8	0.9	1.0
Total	100	100	100
t-value	(Sitting × Standing) = 0.5890, d.f.= 99 p Value = 0.5572, Standard error of difference = 0.039	t (Sitting × Mobile) = 2.2451, d.f.=99 p Value = 0.0270, Standard error of difference = 0.057	t (Standing × Mobile) t = 2.2478, d.f.= 99 p Value = 0.0268, Standard error of difference = 0.047
Range	0.9-4.3	0.7-4.5	1-5.2

Table 3. Percentage distribution of various types of alignment of signature at different body postures

Body Postures	Types of Alignment										Total
	Ascending		Descending		Even		Irregular		Arched		
	No.	%	No.	%	No.	%	No.	%	No.	%	
Sitting Posture	67	67%	5	5%	23	23%	5	5%	0	0%	100
Standing Posture	61	61%	6	6%	29	29%	1	1%	3	3%	100
Mobile Posture	64	64%	2	2%	30	30%	2	2%	2	2%	100

Table 4. Difference in speed within signature at different body postures

Posture	Difference in Speed								Total
	Medium	%	Fast	%	Slow	%	Very Fast	%	
Sitting Posture	17	17%	66	66%	16	16%	1	1%	100
Standing Posture	20	20%	70	70%	7	7%	3	3%	100
Mobile Posture	6	6%	30	30%	5	5%	59	59%	100

Table 5. Percentage distribution of slant of signature at different body postures

Posture	Slant of Signature								Total
	Towards Right from Vertical	%	Towards Left from Vertical	%	Towards both side (Right and Left)	%	Vertical (90˚angle)	%	
Sitting Posture	30	30%	41	41%	13	13%	16	16%	100
Standing Posture	33	33%	36	36%	14	14%	17	17%	100
Mobile Posture	36	36%	33	33%	17	17%	14	14%	100

Table 6. Percentage distribution of various types of pen pressure in signature at different body postures

Body Postures	Types of Pen Pressure						Total
	Low		Medium		Heavy		
	No.	%	No.	%	No.	%	
Sitting Posture	22	22%	51	51%	27	27%	100
Standing Posture	28	28%	55	55%	17	17%	100
Mobile Posture	66	66%	31	31%	3	3%	100

Table 7. Percentage distribution of spacing within signature at different body postures

Body Postures	Spacing within Signature						Total
	Wide		Normal		Squeezed		
	No.	%	No.	%	No.	%	
Sitting Posture	23	23%	42	42%	35	35%	100
Standing Posture	21	42%	45	45%	34	34%	100
Mobile Posture	20	20%	38	38%	42	42%	100

Table 8. Percentage distribution of tremor in signature at different body postures

Body Postures	Tremor				Total
	Present		Absent		
	No.	%	No.	%	
Sitting Posture	8	8%	92	92%	100
Standing Posture	12	12%	88	88%	100
Mobile Posture	21	21%	79	79%	100

Table 9. Percentage distribution of commencement in sigature at different body postures

Body Postures	Commencement in Signature														Total
	Normal	%	Spurious	%	Tapering	%	Curved Strokes	%	Hooked Strokes	%	Rounded	%	Arched	%	
Sitting Posture	30	30%	62	62%	4	4%	1	1%	0	0	2	2%	1	1%	100
Standing Posture	28	28%	64	64%	4	4%	0	0	1	1%	2	2%	1	1%	100
Mobile Posture	29	29%	65	65%	2	2%	1	1%	0	0	2	2%	1	1%	100

Table 10. Percentage distribution of termination in sigature at different body postures

Body Postures	Termin-ation														Total
	Normal	%	Extended	%	Tapering	%	Curved Strokes	%	Hooked Strokes	%	Rounded	%	Ticked	%	
Sitting Posture	31	31%	10	10%	49	49%	2	2%	2	2%	1	1%	5	5%	100
Standing Posture	37	37%	10	10%	45	45%	1	1%	1	1%	1	1%	5	5%	100
Mobile Posture	29	29%	12	12%	52	52%	2	2%	1	1%	0	1%	4	4%	100

Medium pen pressure in signature was found more in standing position (55%) whereas heavy pen pressure was more in sitting position (27%). In mobile position pen pressure in signature was is found low pen pressure (66%). Percentage distribution of spacing within signature at different body positions was shown in Table 7. 'Normal' spacing within signature is found highest in standing position (45%) followed by sitting position (42%) and mobile position (38%). 'Wide' spacing within signature is observed highest in sitting position (23%) followed by standing position (21%) and mobile position (20%).Table 8 shows the percentage distribution of tremor in signature at different body positions. 'Tremor' in signature is found maximum in mobile position (21%) followed by standing position (12%) and sitting Position (8%). Table 9 shows percentage distribution of commencement in signature at different body positions. It was observed that while doing the signature, 'spurious commencement' of signature of respondents was maximum in mobile position (65%) followed by standing position (64%) and sitting position (62%). While other forms of commencement are least distributed. The percentage distribution of termination in signature at different body positions are shown in Table 10. It was observed that while doing the signature, 'tapering end' of signature of respondents was found maximum in mobile position (52%) followed by sitting position (49%) and standing position (45%) while other forms of termination are least distributed in each position. Table 11 shows the percentage distribution of simplification of signature at different body positions. It was observed that while doing the signature 49% abbreviation was found in all three positions in signature of respondents. The percentage distribution of combination of signature at different body positions are shown in Table 12. It was observed that maximum signature of respondents are found in combined form that is in mobile position (67%) followed by Standing position (66%) and sitting position (66%).

Table 13 shows the percentage distribution of Awkward looking forms of sigature at different body positions. It was observed that maximum respondent's signature had awkward looking forms when doing in mobile position (49%). Table 14 shows the percentage distribution of meaningless marks in signature at different body positions. 'Meaningless marks' in signature is found maximum in standing position (68%) followed by mobile position (67%) and sitting position (66%). To determine the level of significance various test of significance was performed. Test of significance ($\chi 2$ test) was performed between movement of hand in signature in different body positions and shown in Table 15. Statistically significant difference were observed in various hand movements of signatures in different body positions. [(sitting × standing) positions $\chi 2$= 82.395, d.f. = 2, p value= 0.0001, (sitting × mobile) positions $\chi 2$ value= 131.74, d.f. = 2, p value= 0.0001 and (standing × mobile) positions $\chi 2$ value=22.303, d.f. =2, p value= 0.0001].

Test of significance ($\chi 2$ test) of pen pressure between different body positions (Table 16), pen pressure of signature is highly significant between two combinations sitting and mobile positions ($\chi 2$ = 43.195, d.f. = 2, p Value= 0.0001) and standing and mobile positions ($\chi 2$ =29.46, d.f. =2, p Value= 0.009). It is non-significant in sitting and standing positions ($\chi 2$= 3.14, d.f. = 2, p Value= 0.2080), thus it can be conclude that while doing signature in sitting and standing positions type of pen pressure is quite similar. Test of significance (χ^2 test) of spacing within signature between different body positions shown in Table 17. χ^2 values calculated for spacing within signature is non-significant in all three combinations (sitting × standing) positions, χ^2= 0.5396, d.f. = 2, p Value= 0.7635, (sitting × mobile) positions, χ^2 = 0.3465, d.f. = 2, p Value= 0.8409 and (standing × mobile) positions, χ^2 = 1.4569, d.f. =2, p Value= 0.4827.

Table 11. Percentage distribution of simplification of sigature at different body postures

Body Postures	Simplification				Total
	Simple		Abbreviation		
	No.	%	No.	%	
Sitting Posture	51	51%	49	49%	100
Standing Posture	51	51%	49	49%	100
Mobile Posture	51	51%	49	49%	100

Table 12. Percentage distribution of combination of sigature at different body postures

Body Postures	Combination of Signature				Total
	Combine		Separate		
	No.	%	No.	%	
Sitting Posture	66	66%	34	34%	100
Standing Posture	66	66%	34	34%	100
Mobile Posture	67	67%	33	33%	100

Table 13. Percentage distribution of awkward looking forms of sigature at different body postures

Body Postures	Awkward looking forms				Total
	Yes		No		
	No.	%	No.	%	
Sitting Posture	41	41%	59	59%	100
Standing Posture	41	41%	59	59%	100
Mobile Posture	49	49%	51	51%	100

Table 14. Percentage distribution of meaningless marks in sigature at different body postures

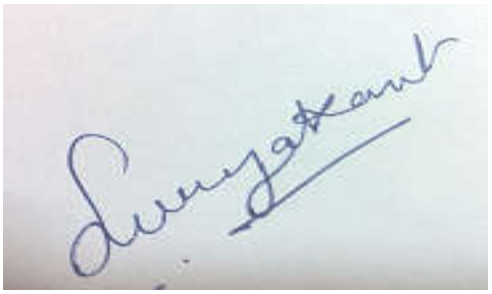
Body Postures	Meaningless marks				Total
	Present		Absent		
	No.	%	No.	%	
Sitting Posture	66	66%	34	34%	100
Standing Posture	68	68%	32	32%	100
Mobile Posture	67	67%	33	33%	100

Table 15. Test of significance (χ^2 test) of movement of hand in signature between different body postures

Postures	χ^2 Value	d.f	p value
Sitting × Standing	82.395	2	0.0001
Sitting × Mobile	131.74	2	0.0001
Standing× Mobile	22.303	2	0.0001

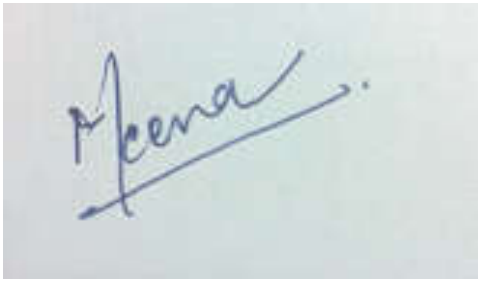
Table 16. Test of significance (χ^2 test) of pen pressure between different body postures

Postures	χ^2 Value	d.f	p value
Sitting × Standing	3.14	2	0.2080
Sitting × Mobile	43.195	2	0.0001
Standing × Mobile	29.46	2	0.009
Range	0.9-4.3	0.7-4.5	1-5.2

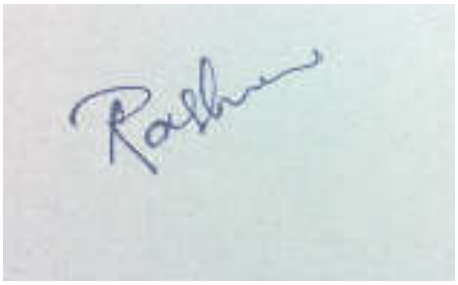


Ascending Alignment

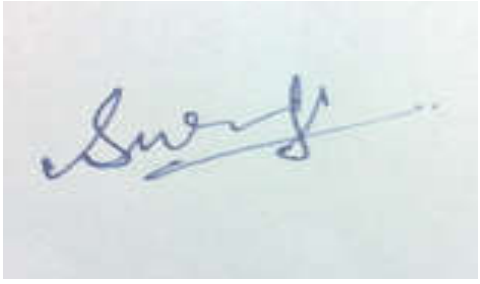
Abbreviation in signature



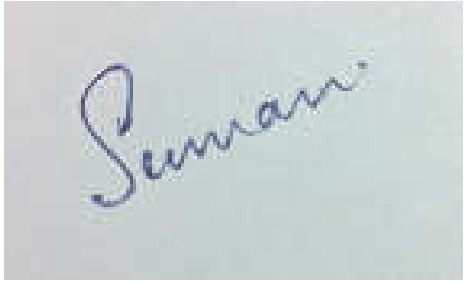
Curved stroke in termination of signature



Extended termination in signature



Hooked stroke in commencement of signature



Spacing between letter 'S' and 'u'

Table 17. Test of significance (χ^2 test) of spacing within signature between different body postures

Postures	χ^2 Value	d.f	p value
Sitting × Standing	0.5396	2	0.7635
Sitting × Mobile	0.3465	2	0.8409
Standing × Mobile	1.4569	2	0.4827

Test of significance (χ^2 test) of tremor in signature between different body positions. Significance χ^2 values were obtained between Sitting × Mobile position (χ^2 = 6.815, d.f.=2, p-value=0.0090) (Table 18). Table 19 shows $\chi 2$ value of combination of signature in various positions i.e. the differences are non-significant between sitting × mobile positions, ($\chi 2$ = 0.0224, d.f. = 2, p Value= 0.9888) and standing × mobile positions, ($\chi 2$ = 0.0224, d.f. =2, p Value= 0.9888). Test of significance ($\chi 2$ test) of awkward looking form of signature between different body positions are shown in Table 20.

Table 18. Test of significance (χ^2 test) of tremor in signature between different body postures

Postures	χ^2 Value	d.f	p value
Sitting × Standing	0.888	2	0.3460
Sitting × Mobile	6.815	2	0.0090
Standing × Mobile	2.93	2	0.0869

Table 19. Test of significance (χ^2 test) of combination of signature between different body postures

Postures	χ^2 Value	d.f	p value
Sitting × Mobile	0.0224	2	0.9888
Standing × Mobile	0.0224	2	0.9888

Table 20. Test of significance (χ^2 test) of awkward looking form of signature between different body postures

Postures	χ^2 Value	d.f	p value
Sitting × Mobile	1.2929	2	0.2555

Table 21. Test of significance (χ^2 test) of meaningless marks in signature between different body postures

Postures	χ^2 Value	d.f	p value
Sitting × Standing	0.09045	2	0.7636
Sitting × Mobile	0.02244	2	0.8809
Standing × Mobile	0.022	2	0.8821

There is non-significant differences are observed for awkward looking forms of signature is in sitting × standing positions ($\chi 2$= 1.2929, d.f. = 2, p Value= 0.2555). χ^2 value of meaningless marks in signature in various combination of positions i.e. (i) Sitting× standing (ii) sitting × mobile (iii) standing × mobile are shown in Table 21. Presence of meaningless marks in signature is non-significant in all positions (sitting × standing, $\chi 2$= 0.09045, d.f. = 2, p Value= 0.7636), (sitting × mobile, $\chi 2$ = 0.02244, d.f. = 2, p Value= 0.8809 (standing × mobile, $\chi 2$ = 0.022, d.f. =2, p Value= 0.88210).

Conclusion

Our findings show that movement of hand shows highly significant difference in all three body positions thereby movements of hand do changes with as position changes. Pen pressure is also a very important hidden feature and it was highly significant in (sitting × mobile) and (standing × mobile) positions but found non- significant with (sitting × standing) positions thereby pen pressure in signature moderately change in all three positions. Spacing failed to show any significant variation in all three body positions. Size of signature may have little importance but in some signatures the size may play a significant role in determining their genuineness. Our study revealed significant difference in size of signature between positions in (sitting × mobile) and (standing × mobile) but not with (sitting × standing). So size of signature does moderately changes with as positions changes. A tremor occurs due to several reasons but mainly due to inappropriate muscular coordination. In the present study only (sitting × mobile) shows significant variation. It can be concluded that in most of the studied features movement of hand, pen pressure and size of signature show maximum variation with changes in positions. As no prior data were available for comparisons therefore, no comparison could be made. This is perhaps the first report on signature variations in different body positions. Further study with more samples will not only help to proof the hypothesis but can also help to estimate personal identity of the writer.

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