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Effects of Writing Position on Handwriting in Forensic Analysis

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ABSTRACT

Handwriting is a distinct characteristic influenced by individual motor skills, cognitive aptitude, and surrounding circumstances. Forensic handwriting analysis is critical in determining the authenticity of documents, especially in legal conflicts involving contested wills or contracts. The study collected 180 handwriting samples from 60 individuals, each writing in three different positions on plain A4 paper with a Reynolds Ballpoint pen (0.7mm). The primary handwriting qualities examined were writing slant, alignment, letter size, fluency, letter spacing, and pen pressure. Statistical analysis was used to see if writing position had any effect on these characteristics. The findings revealed no significant variation in slant or alignment across different writing positions. However, there were significant changes in letter size, fluency, spacing between letters, and pen pressure. The findings indicate that, whereas body position has little effect on slant or alignment, it does have a significant impact on letter size, fluency, spacing, and pen pressure. Furthermore, variations in writing position might have an impact on various handwriting traits that should be taken consideration during forensic document inspection. This study helps understand handwriting diversity and highlights the relevance of body posture in forensic investigation.

Keywords: *Handwriting Traits, Writing Positions, Factors affecting handwriting, Variations in handwriting traits.*

1. INTRODUCTION

Handwriting is frequently seen as a distinct personal attribute influenced by an individual's fine motor abilities, cognitive processes, and environmental influences [1,13]. Forensic document examination, a field of study that uses distinguishing handwriting traits to assess the authenticity of documents, has traditionally focused on variables such as age, health, and psychological condition [2,10]. However, one issue that has not been well investigated in forensic handwriting analysis is the impact of body posture during the writing process. The position in which a person writes—whether seated, standing, or lying down—can impact a variety of handwriting characteristics, including size, slant, pressure, stroke consistency, and legibility [3,14]. Understanding the effect of body posture on handwriting is critical, especially in the setting of disputed documents in legal matters, such as challenged wills or contracts, where handwriting variations are frequently important to the proceedings [15,18].

The term "handwriting" typically refers to someone writing with a pen or pencil. Comparisons of handwriting are founded on the ideas that no two writers are entirely same and that while no two writers write in the same manner, there are traits that appear repeatedly in every writer's work. Document examiners compare this set of features, which are individual to each person [4,12].

Handwriting analysis plays an important role in forensic science, helping to confirm if documents are genuine in legal situations. When there are disputes over documents, like a will that is being challenged or a contract that might be fake, the

handwriting can become a major issue [5,16]. Sometimes, one side argues that differences in handwriting come from how the writer is positioned—like sitting while creating samples but maybe lying down or standing when writing the document in question [6,17]. That's when forensic experts step in to decide if these handwriting differences are due to the writer's posture or if other reasons, like deliberate forgery, health issues, or age, might explain the variations. So, figuring out how body position affects handwriting is essential for thorough forensic document analysis [7,19].

Understanding how body position affects handwriting is important for forensic handwriting analysis. Even though research in this area has progressed, there's still a lot we don't know about how different postures impact handwriting characteristics [20]. Since body position could be a factor in the differences we see in handwriting, it's vital to take this into account when examining questioned documents, especially in legal situations [8,9].

2. BACKGROUND OF THE STUDY

Previously numerous studies have been performed on how body posture influences handwriting across different positions: sitting, standing, and lying down. Kumar and Patel (2024) found that lying down caused greater variation in handwriting, particularly with letter spacing and pressure consistency [21]. Similarly, Rosenberg and Daugherty (2022) observed increased variability in pressure and stroke smoothness when writing in prone or standing positions [22]. Miller et al. (2021) noted that the prone position led to inconsistent letter size and slant, affecting legibility [23]. Grasso et al. (2018) confirmed that reclining positions led to uneven and slanted letters due to pressure changes [24]. Bartz and Herz (2017) similarly noted that writing in a prone position resulted in harder-to-read handwriting because of varying pressure [25]. Dziedzic (2015) emphasized that lying positions caused the greatest variability in pen pressure, margin width, and letter height, especially with a vertical writing surface [26].

This study aims to build on previous work by exploring how different body positions—like sitting, standing, and lying down—affect handwriting traits, including slant, alignment, letter size, fluency, spacing, and pressure. By focusing specifically on body position, the research seeks to find out if changes in handwriting due to different postures are noticeable enough for forensic handwriting analysis. It's important to grasp how body position influences handwriting to improve methods in forensic document examination, especially in situations where there are disputes over handwriting, as different body positions might explain the differences found between questioned samples and reference ones. This research will enhance the understanding of handwriting variability by exploring the connection between body position and handwriting, providing valuable insights for forensic science and legal investigations.

3. MATERIALS AND METHODS

For the study a total of 180 handwriting samples in English language (format of "London Letter") were collected from 60 different individual with three different writing positions viz. Sitting, Standing and Lying position. The samples were written by Reynolds Ballpoint pen (0.7mm) on plain A4 size paper as shown in fig. 1.

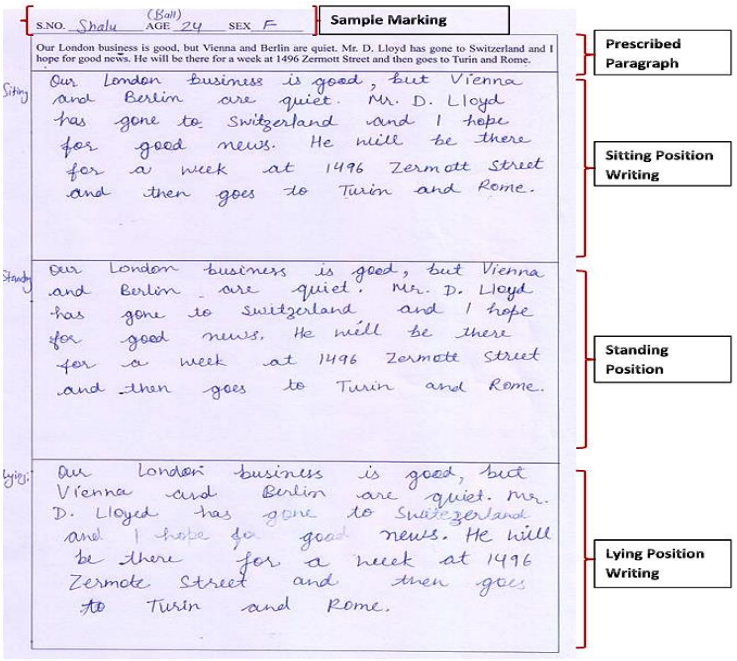

Fig 1: Sample collected from an individual with three different writing positions (Sitting Position, Standing Position and Lying Position) using a Reynolds Ballpoint Pen.

The samples were analyzed for similarities and differences in handwriting characteristics using a Magnifying glass, Digital Microscope (100x – 1000x), 310 HP Printer scanner, PC System (LAPTOP-8T42I9P6 Windows 11) and Visible light sources. Specific codings were provided to the characteristics as follows for statistical purposes:

- Writing Slant: Forwarded = 1, Vertical = 2, Backward = 3
- Writing Alignment: Uphill =1, Straight = 2, Downhill = 3
- Letter Size: Large = 1, Medium = 2, Small = 3
- Fluency: Fluent =1, Medium = 2, Least Fluent= 3
- Spacing between letters: Wide = 1, Medium =2, Narrow = 3
- Pen pressure: Heavy Pressure = 1, Medium Pressure = 2, Light Pressure = 3

Null Hypothesis: A null hypothesis was established, suggesting that writing positions do not significantly influence writing slant, alignment, letter size, writing fluency, letter spacing, pen pressure, or the formation of individual letters.

4. RESULTS & DISCUSSION

The samples were examined for different class characteristics like writing slant, writing alignment, letter size, fluency, relative spacing between letters, pen pressure, and other specific individual characteristics that are may or may not be subconsciously altered while different writing positions.

After a detailed study of all the handwriting samples collected from different writing positions, the statistical result was obtained for checking the significance or otherwise between the similarities and dissimilarities in the writing characteristics as mentioned above in the analysis by using "ANOVA Two Way without Replication" shown in Tables 1, 2, 3, 4, 5 and 6.

Table 1 shows that the calculated p-value for slant due to writing positions is greater than 0.05. Therefore, we accept the null hypothesis, indicating that there is no significant difference in slant due to changes in writing position. As a result, changing the writing position have no impact on writing slant.

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.211111	2	0.105556	0.153836	0.857527	3.047012
Within Groups	121.45	177	0.686158			
Total	121.6611	179				

Table 1: ANOVA result of writing slant variations due to different writing positions

Table 2 shows that the calculated p-value of alignment due to writing positions is greater than 0.05. Therefore, we accept the null hypothesis, indicating that there is no significant variation due to changes in writing positions. As a result, changing writing position have no impact on writing alignment.

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.744444	2	0.372222	0.623994	0.536975	3.047012
Within Groups	105.5833	177	0.596516			
Total	106.3278	179				

Table 2: ANOVA result of writing alignment variations due to different writing positions

Table 3 shows that the calculated p-value of letter size due to writing positions is less than 0.05. Therefore, we reject the null hypothesis indicating that there is significant variation due to changes in writing positions. As a result, changing writing position have impact on writing letter size.

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	8.844444	2	4.422222	21.46435	4.5E-09	3.047012

Within Groups	36.46667	177	0.206026
Total	45.31111	179	

Table 3: ANOVA result of writing letter size variations due to different writing positions

Table 4 shows that the calculated p-value of fluency due to writing positions is less than 0.05. Therefore, we reject the null hypothesis indicating that there is significant variation due to the writing positions. As a result, changing writing position have impact on writing fluency.

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.677778	2	0.838889	3.094477	0.047758	3.047012
Within Groups	47.98333	177	0.271092			
Total	49.66111	179				

Table 4: ANOVA result of writing fluency variations due to different writing positions

Table 5 shows that the calculated p-value of spacing between letters due to writing positions is less than 0.05. Therefore, we reject the null hypothesis indicating that there is significant variation due to the writing positions. As a result, changing writing position have impact on writing spacing between letters.

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.144444	2	0.572222	4.419636	0.013396	3.047012
Within Groups	22.91667	177	0.129473			
Total	24.06111	179				

Table 5: ANOVA result of writing spacing between letters variations due to different writing positions

Table 6 shows that the calculated p-value of pen pressure due to writing positions is less than 0.05. Therefore, we reject the null hypothesis indicating that there is significant variation due to the writing positions. As a result, changing writing position have impact on writing pen pressure.

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	62.97778	2	31.48889	163.8471	5.34101E-41	3.047012
Within Groups	34.01667	177	0.192185			
Total	96.99444	179				

Table 6: ANOVA result of writing pen pressure variations due to different writing positions

The statistical analysis results reveal that various aspects of handwriting are influenced by different writing positions. The p-value for writing slant is 0.85, indicating that writing position does not significantly impact slant. This suggests that slant is a stable characteristic, largely determined by habitual writing style and muscle memory, and is not easily altered by body posture. Similarly, the p-value for writing alignment is 0.53, implying that alignment remains unaffected by changes in writing position. This suggests that alignment is primarily influenced by internal focus and coordination rather than external posture.

However, the analysis shows significant variation in other aspects of handwriting. The p-value for letter size is 4.5E-09, which is much smaller than 0.05, indicating that writing position does indeed affect letter size. This suggests that altering the

writing position, such as switching from sitting to standing, may influence the ease and control with which a person writes, leading to changes in the size of the letters. Similarly, writing fluency is also significantly impacted by posture, with a p-value of 0.04. Writing fluency refers to the smoothness and speed of writing, which can be disrupted in less comfortable or natural positions. Positions such as standing or kneeling may cause interruptions in the writing flow, leading to less fluent handwriting.

The spacing between letters is also significantly influenced by writing position, with a p-value of 0.01. This indicates that changing posture can affect hand-eye coordination and lead to inconsistent spacing between letters. For example, writing while standing or in an unusual position may disrupt the natural rhythm of writing, causing varying letter spacing. Finally, pen pressure is significantly affected by writing position, as indicated by a p-value of 5.34E-41. This suggests that posture can alter the pressure applied to the writing surface, potentially making the handwriting lighter or heavier depending on the position in which the person is writing.

In this study, backward ink flow was observed while participants used a ballpoint pen in a lying position. The unusual angle and positioning of the pen in this posture caused disruptions in the normal ink flow. This resulted in the ink flowing backward, leading to inconsistent writing and occasional smudging. The altered pressure and grip on the pen while lying down also contributed to these irregularities, making the handwriting appear uneven and messy.

5. CONCLUSION

Overall, the results show that while slant and alignment are stable regardless of writing position, characteristics like letter size, fluency, spacing between letters, and pen pressure are significantly impacted. These findings emphasize the importance of considering writing posture in forensic handwriting analysis, as changes in body position can lead to variations in handwriting characteristics that need to be taken into account when evaluating the authenticity or variation of documents.

In conclusion, the study highlights the impact of different writing positions on various handwriting characteristics. While certain features, such as slant and alignment, remain unaffected by changes in body posture, other characteristics, including letter size, fluency, spacing between letters, and pen pressure, show significant variations when writing positions are altered. These findings suggest that writing posture plays an important role in influencing handwriting traits, which could have implications in forensic document examination, especially in cases where writing position might be a factor in disputed documents. Forensic experts should consider these potential variations when analyzing handwriting in different contexts, as changes in posture can result in noticeable differences that may affect the interpretation of handwriting characteristics. Further research and studies are necessary to explore these influences in greater detail, especially in real-world scenarios where writing positions may vary based on the individual and the circumstances.

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