

Influence of Writing Posture on the Dimensions of Signatures

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In order to study the influence of writing posture on the dimensions of signatures, the authors asked 21 volunteers to sign their names in 4 different writing positions. Such items as receipts, checks, or short notes are sometimes written or signed in unusual writing positions, which some claim may influence the dimensions or proportions of the writing. The measured parameters (length, height, proportions) that are modified when writing under unusual conditions, as well as the range of these modifications, proved to be variable from 1 writer to another. While the average variation for the writers in this study was low, great variations were observed in some cases. Furthermore, no correlation could be established between the kind of variation observed and the graphical appearance of the signatures.

Introduction

Handwriting is a very complex neuromuscular activity. The handwriting process first activates several cerebral units to generate the graphical representation of a word, and then the action of numerous nerves and tendons is required to create this word on the paper. Considering the numerous parameters involved in this process, many factors may influence handwriting at different levels. Huber (1999) classified the elements which may modify handwriting as follows:

- extrinsic factors which are volition-independent, such as handwriting systems learned at school, physiological impairment, illness, medication, age, or mental state;
- intrinsic factors resulting from a deliberate choice of the writer, such as mimicking the handwriting of relatives during the learning stage, drug or alcohol intoxication, tiredness, or writing circumstances.

Writing circumstances concern conditions such as the writing instrument, the kind of support, the environment, the purpose of the signature, or the writing posture.

Writing conditions of questioned documents are not always comfortable (Ellen 1997), and particular circumstances may be invoked by the proponents to explain spatial dissimilarities between a questioned signature and a series of known signatures. In such cases it may be difficult for the expert to evaluate the likelihood of such

a claim because reference signatures written under similar conditions to those asserted for the questioned signature are rarely available. Without such specimens the forensic document examiner cannot know what variations are liable to be introduced by an unusual writing position.

Ellen (1997) wrote that uncomfortable writing postures, such as standing and taking notes on a note pad, can cause less precision in retracing, closing loops, or fine movements, but that the effects are not pronounced. Concerning writing against a wall, he mentioned a possible increase in the number of strokes per character, but the construction and proportions should not show much variation. Wellingham-Jones (1994) reported the case of a person who claimed to have written with a stretched arm and an inverted hand position. In order to evaluate this assertion, Wellingham-Jones asked 30 people to write under such conditions and observed that some people were unable to do so and that others had few difficulties completing the exercise. For those who managed to perform the exercise, small variations were present, with the most common being a lack of speed and an increase in angularity and tremor.

Totty (1981) and Kelly (1987) report handwriting cases on unusual surfaces, such as the abdomen of a victim and an uninflated balloon. Despite the particular texture and form of the surface, in both cases the identification of the writer was achieved on the basis of the character formation.

These studies did not address the influence of the writing conditions on the size or proportions of the signatures, although these features are likely to be modified under unusual circumstances. For example, Abbey (1999) wrote that relative height proportions in a signature can be influenced by the position of the signature line on a document, especially when the available space is crowded by typing above or below the signature line. She concluded that the signature dimensions and proportions should not be the single factor upon which an examiner bases a conclusion as to genuineness.

The present study was aimed at providing information about the possible influence of the writer's position on signature dimensions and proportions. This information could help an examiner assess the signification of the size variation observed in a given case and to determine whether an extreme variation can be properly attributed to an unusual writing position.

To achieve this aim, differences between signatures written under normal conditions and signatures produced in particular but controlled circumstances were investigated. This paper reports the changes that might occur in unusual postures, in particular the following variables:

- what size parameters (length, height, proportions) are modified;
- how large these modifications are;
- which conditions are liable to bring out the most drastic changes; and
- whether all the writers or groups of writers show similar changes under similar unusual writing conditions.

Methods and Materials

Sampling

Signatures were collected from 21 volunteers recruited among the colleagues of the authors and their relatives. The participants were aged from 22 to 62, 11 were females, 20 were right-handed, and different types of education level and professions were represented.

All the signatures were written with a ballpoint pen on an A4 sheet divided in 3 sections; the participants had to sign 1 time in each section.

While any kind of writing circumstance can be invoked by a signature's proponents, this study focused on 3 unusual postures that might be claimed for realistic situations such as signing a check or receipt. The following writing positions were requested:

- Condition 1: normal position, sitting on a chair at a desk, the document lying on the desk;
- Condition 2: standing, leaning the document against a wall;
- Condition 3: standing, holding a hard support under the document to be signed;
- Condition 4: standing, the document lying on a table.

All the participants had to sign in each condition on 12 different days. This represents a total of 48 signatures for each person.

Measurement

The collected signatures were scanned in grayscale at 300 dpi, and the measurements of height and length were carried out with the image treatment software Adobe Photoshop CS®. The proportions (length/height) were then computed.

Three of the 21 participants appose their signature with distinct full name and last name. For these writers, the analysis was restricted to the last name.

Statistical Analysis

The collected data—length, height, and proportions of the signatures—were statistically processed with 2 kinds of software (Excel®, SPSS®).

- Summary statistics of the size parameters were computed separately for the signatures of each participant for each writing condition. Mean, standard deviation, minimum, and maximum values were calculated. Those data were used to conduct the following studies:
 - o Compare the mean size modification between the normal and an unusual posture, within a writer and between the writers, in order to show any modification trend among the writers;
 - o Compare the size parameter (i.e. length, height, or proportions) under usual and a given circumstance. A Mann-Whitney test was used to determine whether the differences in size parameters were significant (at $p < 0.01$ and $p < 0.05$). Each size parameter and each writing circumstance was examined in turn. The resulting calculations establish which size parameter was most often changed under the imposed writing circumstances and which posture was more likely to lead to variations in the signatures;

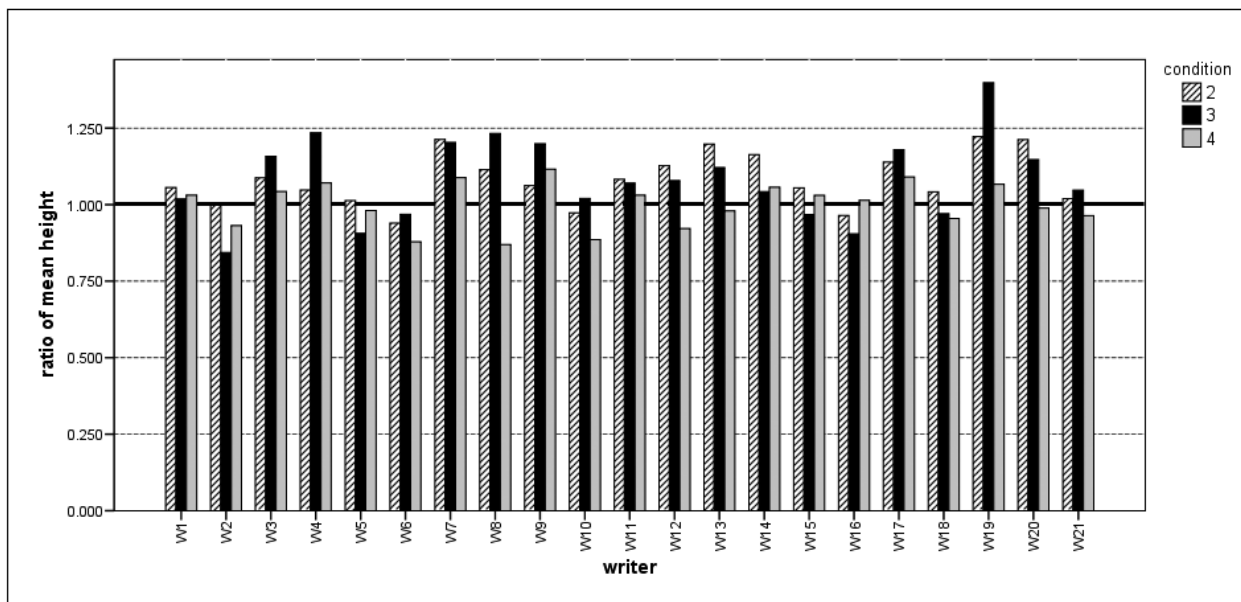


Figure 1. Ratio of the mean value of height between the unusual and the normal conditions for each writer. Condition 2: standing, leaning the document against a wall; Condition 3: standing, holding a hard support where to put the document to be signed; Condition 4: standing, laying the document down on a table.

- o Compare the ratios between maximal (respectively minimal) values of size parameter between the normal and an unusual condition to demonstrate which extreme modification value can be expected in the case of a writing posture; and
- o Compare the standard deviation of size parameters between the normal and an unusual posture to determine whether the writers tended to be less consistent in size features when writing in abnormal conditions.
- Hierarchical cluster analyses were applied on ratios of mean values between an unusual and the normal condition, for each size parameter in turn, to investigate the possible correlation between the graphical appearance of the signature and the modification degree.

Results and Discussion

To evaluate the degree of modification in size parameters between the normal and each unusual condition, the mean values of these parameters were compared for each set of signatures of each writer. The resulting ratios for all parameters (mean value in unusual condition divided by mean value in normal condition) varied globally from

about 0.8 to 1.2, most of the ratios ranging from 0.9 to 1.1. Writer 19 showed an extreme ratio of 1.4 for the height in Condition 3 (Figure 1). Results are illustrated for the height only.

Various configurations of modification among the writers were revealed by the findings. Indeed, some writers increased the dimension in all unusual conditions (for example W7, W9, W17 and W19 for the height), other writers consistently decreased the size (for example W6 for the height), and a last group of participants increased or decreased the dimension given the unusual condition. These results showed that each writer seemed to have his own reaction to the imposed writing conditions.

The significance of the changes demonstrated above was evaluated by using the Mann-Whitney test between size parameters collected in normal and unusual conditions for each writer (Table 1).

The Condition 4 was found to have the least influence on size parameters: for 2 writers, the only significant change was observed for the height; for 4 writers, the length was concerned, 3 of them modifying also significantly the proportions. The Condition 3 was the source of the most frequent size modifications, especially concerning height (8 writers concerned) and proportions (12

	Condition 2 vs 1			Condition 3 vs 1			Condition 4 vs 1		
Writer	Height	Length	Length/ Height	Height	Length	Length/ Height	Height	Length	Length/ Height
1	-	-	-	-	-	-	-	-	-
2	-	-	-	↓↓	↓	-	-	-	-
3	-	-	-	↑↑	-	**	-	-	-
4	-	-	-	↑↑	-	*	-	-	-
5	-	↑	-	-	-	*	-	-	-
6	-	↓	-	-	-	-	↓	-	-
7	↑↑	-	*	↑↑	-	**	-	-	-
8	-	-	-	↑↑	-	-	-	-	-
9	-	-	-	↑↑	-	**	↑	-	-
10	-	-	-	-	↑↑	-	-	-	-
11	-	↑	-	-	-	-	-	-	-
12	↑	-	**	-	-	**	-	↓↓	-
13	↑↑	-	-	-	-	-	-	↑↑	*
14	↑↑	-	**	-	↓	**	-	-	-
15	-	↑↑	-	-	-	*	-	-	-
16	-	↑↑	**	↓	-	**	-	-	-
17	-	↑	-	-	-	-	-	-	-
18	-	↑	-	-	-	*	-	↑	**
19	↑	-	-	↑↑	↑	**	-	-	-
20	↑	-	*	-	-	*	-	-	-
21	-	↑↑	-	-	-	-	-	↑↑	**

Table 1. Results of the Mann-Whitney test on the signatures, for each writer at each condition. Asterisks or arrows indicate a significant variation (*, ↑, ↓: significant at $p < 0.05$; **, ↑↑, ↓↓: significant at $p < 0.01$) and the trend of the variation – ↑ increase, ↓ decrease –, unsuitable for proportions.

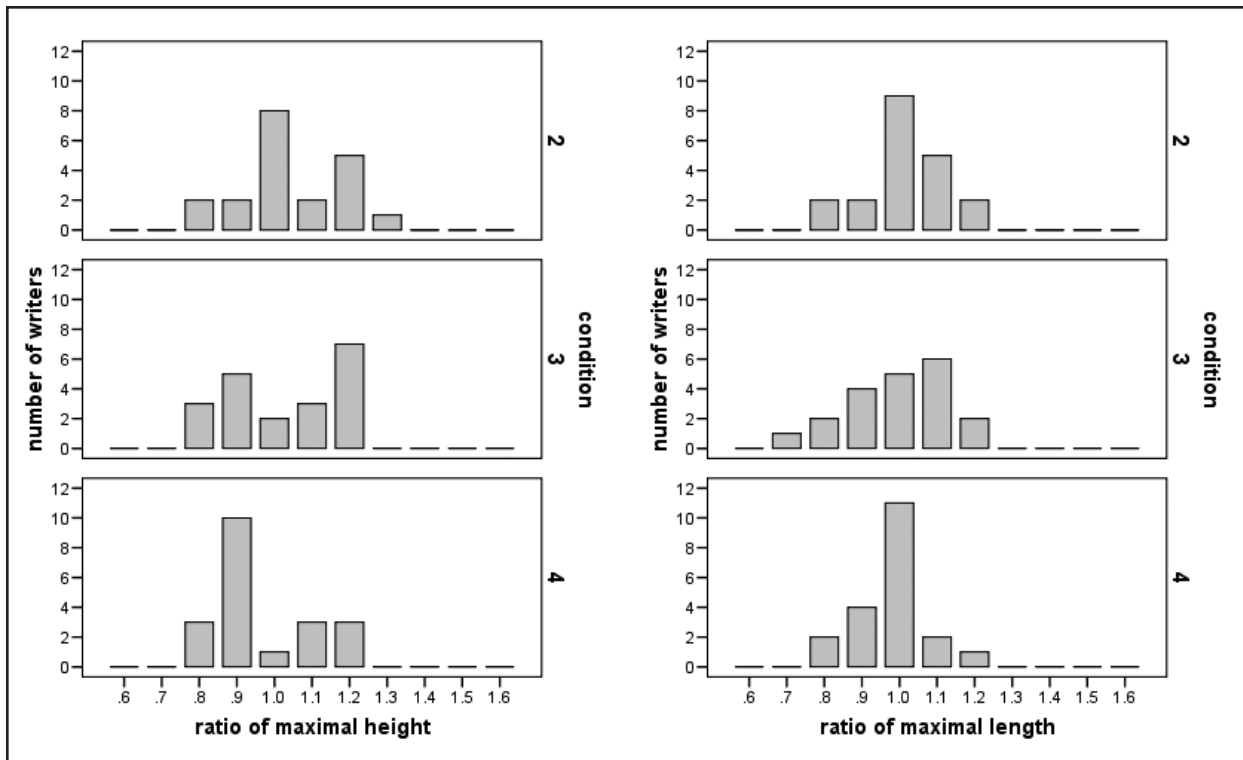


Figure 2. Repartition of the ratios computed between the *maximal* height (left) and length (right) in each unusual condition and in the normal condition, among the 21 writers.

writers). The unstable surface may be a reasonable explanation for the greater variation observed in this Condition 3. Significant modifications were also present in the Condition 2, with 6 writers modifying the height, 8 writers the length, and 5 writers the proportions.

No general tendency concerning the signature size variation caused by unusual writing posture could be drawn from the findings. Indeed, some participants did not show altered signature proportions in signing in any of the unusual conditions, while others were influenced by 1 or more conditions. An examiner cannot predict the general modification caused by a given condition; however, he must keep in mind that particular unusual conditions may modify size parameters in some way.

When a significant change occurs for the signatures of a writer in a given condition, it usually concerns either the length or the height separately; for only 2 writers (W2, W19) in Condition 3 were significant variations in height *and* length observed. More participants modified the size parameters in only 1 dimension, either the height

or the length. When a statistically significant modification in the height or the length was observed, it was in most cases an increase in dimension rather than a decrease.

The estimation of the maximal changes for each writer in each condition was carried out through the computation of the following ratios:

- maximal increase: ratio between the highest value in the unusual condition and the highest value in normal condition (Figure 2);
- maximal decrease: ratio between the smallest value in the unusual condition and the smallest value in normal condition (Figure 3).

Writers were more prone to increase the size of writing under unusual conditions, as demonstrated by the values higher than 1 in Figure 2. The Condition 3 seemed again to have more influence on the extreme modifications, as it included a lot of values lying between 1.2 and 1.3.

Minimal values of the parameters in unusual conditions tended to remain higher than the lowest values in normal posture (ratio >1). This observation suggested that people are less prone to

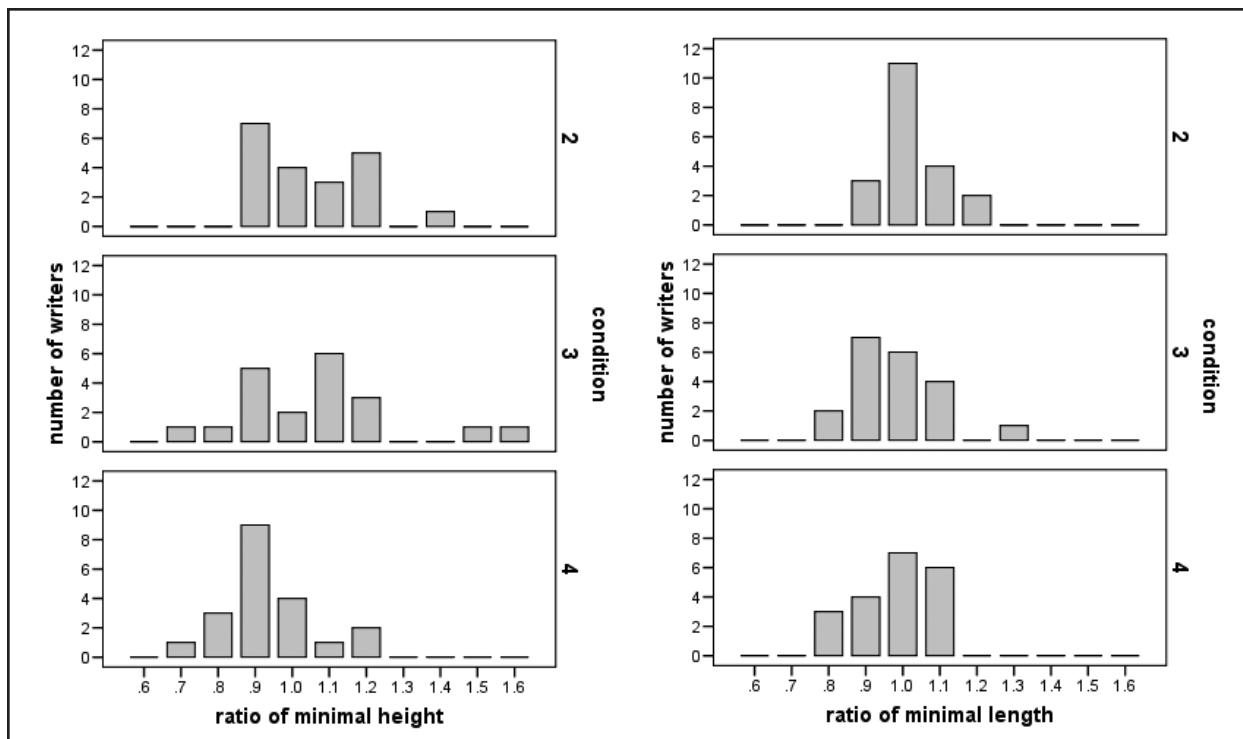


Figure 3. Repartition of the ratios computed between the *minimal* height (left) and length (right) in each unusual condition and in the normal condition, among the 21 writers.

diminish the size of their signatures in an unusual position than to increase it.

The most extreme modifications, all writers included, were about the same in each condition: 0.8 for the ratio between minimal values and 1.3 between maximal values (Figures 2 and 3). These results indicated that, in an unusual position, a writer can reduce a dimension of his signature down to 0.7 smaller than the smallest dimension of the same parameter in normal position. In the same way, a writer can increase his signature dimension up to 1.3 larger than the largest normal signature. These extreme values provide an indication of the widest size variations to be expected in similar unusual conditions as tested in this study. Given the small population size of our study, the possibility of even greater modifications by other writers cannot be excluded.

The intrasubject variability of the tested parameters was evaluated by comparing their standard deviation among the 4 writing postures for each writer. Some writers showed more variation in unusual conditions, while others showed less variation; other participants showed more or

less variation given the unusual condition, and a last group of writers kept the same variation range in unusual and normal conditions. Therefore, unexpectedly, it was possible to observe less variability among signatures written in unusual than in normal conditions.

According to their graphical appearance, 4 main groups of signatures were established:

- Group A (10 signatures): common "written signature," with no emphasis nor disproportionate ascending or descending strokes.
- Group B (3 signatures): signatures with disproportionate ascending and descending strokes.
- Group C (3 signatures): signatures with dynamic descending stroke at the end.
- Group D (5 signatures): signatures with dynamic flourishes such as circling, underlining, final retracing.

The findings demonstrated that the signatures showing similar ratios of mean values between an unusual and the normal condition were not necessarily characterized by similar graphical aspects. It is therefore not possible to reliably

infer the modification degree to be expected in a particular condition on the basis of the graphical appearance of the signature, whatever the size parameter is.

Conclusion

The size parameters (height, length, and proportions) that are modified when writing in unusual conditions, as well as the range of this modification, proved to be variable from 1 writer to another. Additionally, within the writing of 1 individual, the modification (in terms of increase or decrease) was not necessarily identical among the different selected writing postures. The average variation for most of the writers remained low—the ratios between the mean value of the parameters in each unusual condition and the normal condition varied between 0.8 and 1.2. However, the most extreme variations indicated that in an unusual posture a writer can reduce a dimension of his signature down to 0.7 smaller than the smallest dimension of the same parameter in normal position, but he can also increase his signature dimension up to 1.3 larger than the largest normal signature.

The influence of the writing posture on the size parameters proved to be different according to the posture. The most influential condition was the condition where people were standing, holding a hard support under the document to be signed (Condition 3); the least influential condition was the writer standing, signing the document lying on a table (Condition 4). As Condition 3 produced the most extreme variation and used an unstable support, it would seem that what lead to a modification in size parameters was the instability of the support rather than the position of the writer.

No correlation could be established between the kind of variation observed and the graphical appearance of the signatures. Therefore, it was not possible to reliably infer the size modification to be expected in a particular condition on the basis of the graphical appearance of the signature.

The findings of this study support the statement of Huber (1999) concerning the writing posture: "The affects (*sic*) of extreme conditions are highly variable and little can be proffered as to what may be expected in any given situation." As signature dimensions did not vary much in unusual conditions, but extreme variations could be observed in some cases, a decision of authenticity or forgery should never be based on the single comparison of the dimensions. Elements such as dynamism, character construction and line quality remain

the key elements in the comparison process of signatures.

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