

Spray paint writings on walls: Is conventional reference material adequate for comparison?

Liv Cadola¹, Sandrine Cuany², Céline Weyermann², Raymond Marquis²

¹ Université du Québec à Trois-Rivières, Département de Chimie, Biochimie et Physique, 3351 Boulevard des Forges, Trois-Rivières, QC, G9A 5H7, Canada

² Université de Lausanne, Faculté de droit, des sciences criminelles et d'administration publique, Ecole des sciences criminelles, Batochime 1015 Lausanne, Suisse

Forensic document experts may be asked to examine questioned items written with spray paint on vertical surfaces. In such cases, they may not have available reference material written under similar conditions. A critical question follows: is conventional reference material (e.g. executed with a ballpoint pen on a paper placed horizontally) suitable for comparison? In order to investigate the influence of this particular writing condition, samples written with spray paint on vertical surfaces were compared to samples written on paper by a same writer. This comparison was carried out on the writings of 27 volunteers. The results have shown that the amount of similarities between both writing conditions was strongly dependent on the writer. Overall, while some similarities in style (script, cursive), shape and construction of letters were observed, several discordances in connections, slant, spacing, size and proportions were highlighted between both writing conditions. Therefore, the findings of this study stress out the need for reference material produced under similar conditions when examining questioned spray paint writings on vertical surfaces.

Keywords: Graffiti, tag, spray paint, writing on vertical surfaces, reference material, examination.

Introduction

This paper is focused on the examination of vertical spray paint writings. Such writings are considered as the simplest form of graffiti. Walls writings' writers are not willing to produce a work of art, but a limited amount of legible text (Marsh 2007) that can be threatening, indecent or disrespectful. By the message it conveys, it also differs from tags (i.e. stylized signatures used by a person or a group).

In Switzerland, according to the Art. 144 of Swiss Criminal Code¹, authors of wall writings are liable to a penalty up to three years for property damage. This sentence can be aggravated if the content of the writings classifies under the offences against honor such as defamation (Art.173) or slander (Art.174). In the state of New York, according to the NYC Penal Law² section 145.60 making graffiti is a class A misdemeanor

and possession of graffiti instruments (145.65) is a class B misdemeanor. The New York State Penal Law sections 145.00, 145.05 and 145.10 (Criminal Mischief) can also be charged against someone making graffiti. The class of the felony (A misdemeanor, E felony or D felony) depends on the value of the damaged property.

It can occur that an expert statement is requested to help infer the author of questioned wall writings. However, examiners dealing with this type of case currently have to face a major problem: the absence of reference material written under similar conditions (i.e. surface and instrument). It may be disputed whether conventional reference material (e.g. executed with a ballpoint pen on a paper placed horizontally) is suitable for comparison. This paper seeks to investigate the influence of this particular writing condition on handwriting features.

¹ <https://www.admin.ch/opc/en/classified-compilation/19370083/201803010000/311.0.pdf> (last access March 2018)

² <http://ypdcrime.com/penal.law/> (last access May 2018)

Various researches highlighted the importance of comparing questioned documents and reference documents produced under similar conditions (Hilton 1992; Huber, 1999; Locard 1940). Studies have shown that, at the exception of extreme circumstances, different writing instruments and positions of the writer and/or the surfaces do not seem to prevent the examination to be completed successfully (Dreger 1997; Equey *et al.* 2008; Hilton 1984; Kelly 1978; Mathyer 1969; Sciacca *et al.* 2008; Sciacca *et al.* 2011; Thiéry *et al.* 2013; Totty 1981). While some within-writer features are conserved under different writing conditions, it is generally agreed that it is fundamental to recognize the variations in handwriting features introduced by such changes in order to distinguish them from between-writer variation. This is even more important when dealing with wall writings where studies are still rare (Jasuja *et al.* 2014; Junker and Köller 1997).

Therefore, the objective of this research is to highlight similarities and differences between handwriting specimens of a writer written under conventional conditions and with spray paint on a vertical surface. The comparison results, including 27 writers (hereafter labelled #1 to #27), will help evaluate the relevance of using conventional reference material (e.g. ballpoint pen writings on paper) for an examination of questioned spray paint writings on a wall.

Methods and materials

Twenty-seven volunteers, either teachers or students from the University of Lausanne, were asked to produce writings on vertical surfaces using a spray paint can, as well as conventional writing samples. Spray paint writings were produced on a large white paper surface (200 cm X 91 cm) attached on a wall at the sight height of the participant. Writings were produced with a common black Montana Hardcore spray paint can selected to minimize paint running and absorption on the paper. Before the handwriting collection, the participants were asked whether they were experienced writers with spray paint. Four participants had previous experience in manipulating paint cans for artistic activities. Nevertheless, every participant had the opportunity to train writing with the spray paint before applying the first sentence of the first session.

For every writer, spray writings and conventional texts were collected during three sessions

that occurred on three different days. Each participant was asked to produce three wall writings per session, for a total of nine for each volunteer. The short threatening French sentence « *sale chien tu vas payer* » was selected and dictated orally to each participant at the beginning of each session. No recommendation was suggested about the way the participants should write. At the end of each session, participants had to answer a survey to report any possible difficulty encountered during the exercise and were also asked to copy a reference printed text with a ballpoint pen on a sheet of paper, sitting at a table. The reference text contained all the words present in the spray paint text but organized differently, as well as additional words. The reference text was as follows: « *Mme K. Niche était en train de payer son café quand son chien s'en est allé en courant. Elle a hurlé - Où vas-tu Kiki ? - et l'animal est revenu couvert de boue. Sale des pattes aux oreilles.* ».

In addition to the three sessions, a fourth reference text on paper was collected from every writer, in order to check whether the spray sessions had any influence on the production of the conventional material. A sample of the writings produced by every participant is presented in the supplementary material (SI 1).

The three spray paint writings of each session were photographed. Knowing the difficulty in analyzing the construction of texts produced with a spray paint can, all the sessions were also video-recorded. Analyses were conducted on the pictures, the videos, and the original sheets of paper according to standard forensic document procedures normally applied to conventional handwritten text (ENFSI 2015). Features of general graphical aspect (such as writing style, legibility, size, proportions, layout, spacing and slant) and particular details (such as shape and characters construction, connections of letters and diacritics) were first examined and compared between the spray paint writings of a same writer, to get an overview of the within-writer variation between sentences of a given session, and between different sessions. The same features were then examined on the conventional samples and compared – for each participant – to those observed on the spray paint writings. Similarities and differences were noted. All the procedure was conducted visually. Moreover, a quantitative test analysis has been conducted on the proportions of letters “ h ”, “ p ” and “ y ” on a sample of ten participants. Finally, the influence of the spray painting conditions on handwriting features was

discussed in order to evaluate the relevance of using conventional sample during an examination of wall writings.

Results

Writing style

Among the twenty-seven volunteers, twenty-two wrote all the spray paint text with lowercase letters, four with block capitals uppercase letters and volunteer #3 used both. Among those who wrote in lower case letters, six used a cursive style, seven a script and nine mixed the two styles. All the participants showed the same style on their ballpoint handwritten samples (Figure 1).

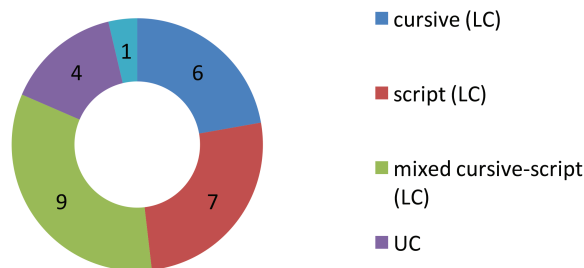


Figure 1. Writing style used by 27 volunteers. Uppercase letters (UC) and lower case letters (LC).

Legibility

People tended to slow down their handwriting when using a spray paint can. Consequently, a better legibility was observed for all the participants when compared with conventional material (Figure 2).

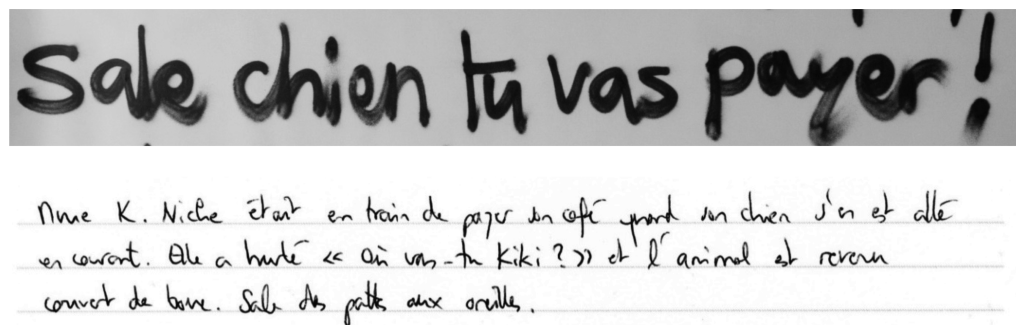


Figure 2. Volunteer #23 writings with a spray paint can appeared to be more legible than the ones with a ballpoint pen (below).

Layout

Results showed that the layout was strongly dependent on the writer. The majority of the participants centered their writing on the paper and some of them used the first sentence of the first session to adapt their writings to the size of the paper (Figure 3).

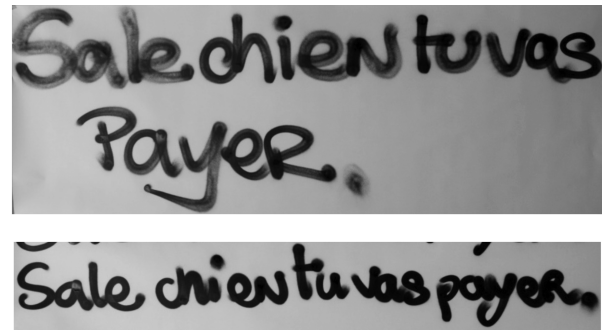


Figure 3. After the first sentence written on two lines, volunteer #21 adapted his handwriting to fit into the paper size for the following sentences.

Seven volunteers reduced the spacing between the final words and letters in order to fit in the paper and directly adapt to the spatial constraint starting with the second sentence of session one (Figure 4).

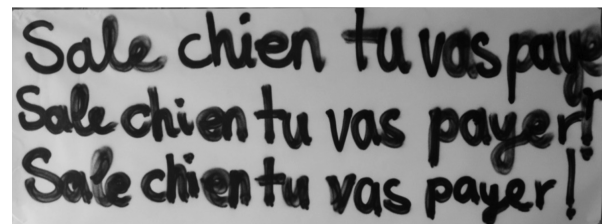


Figure 4. Volunteer #25 reduced the space between the words "vas" and "payer" and the final letters of the word "payer" to adapt to the available space. In sentences two and three, he directly adapted to the spatial constraint.

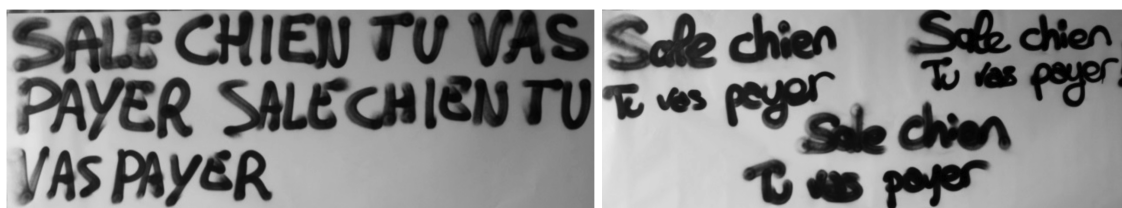


Figure 5. All along the sessions, volunteer #9 used two lines to write one sentence, and started writing sentence two directly at the end of sentence one (left). Volunteer #27 always wrote the first sentence on two lines on the top left of the paper, the second on the top right and the third centered on the bottom of the paper (right).

Finally, two participants (#9 and #27) kept a special layout along all sessions (Figure 5).

The conventional material was collected on lined paper, therefore no comparison of the layout was carried out between the spray paint writings and the conventional ones.

Spacing between letters and words

For seven participants, relative spacing between words on the wall writings was reduced when compared to the conventional handwriting sample, as previously noticed by Junker and Köller (1997). In this study, this might however be influenced by the limited size of the paper surface (Figure 4). The size constraint appeared to have the highest impact on the first sentence (which was compressed at the end), while the writers often adapted from the second sentence, in order to better fill the space. For this reason, examination of spacing variations was especially focused on the second and third sentences. For twelve volunteers, space between words and characters stayed constant even if the stroke thickness due to the use of the spray paint may give the impression of a reduced spacing. For eleven others, space between letters or words was reduced and for the last four space increased compared to ballpoint pen writings.

Slant

In standard reference material, some volunteers presented a regular slant orientation (right, left or no slant). For some others, the slant varied between different words or sessions. For more than half of the participants the writings on walls were straightened up when compared to the writing on paper, whatever the slant direction observed on paper (Figure 6). Moreover, no slant was observed for samples that were already straight in the conventional material. This was also observed by

Junker and Köller (1997). As an exception, one volunteer significantly changed his writing slant for the last sentence of the last session (Figure 7). After discussing with the volunteer, this change occurred to test another way of writing and did not represent his natural slant. These findings conflict with Jasuja *et al.* (2014), who did not observe any slant change between spray paint writings and normal writings.

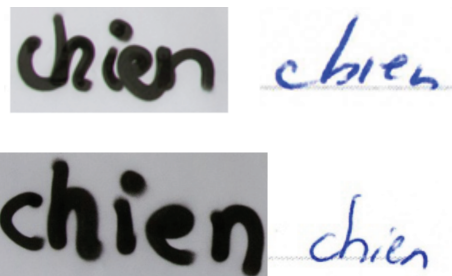


Figure 6. Participants #6 (top) and #11 (bottom) showed a right slant in their conventional handwriting and straightened up the writing when using a spray paint can.

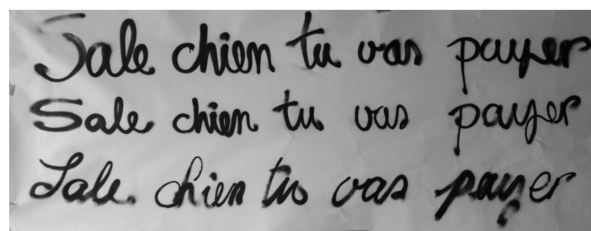


Figure 7. Volunteer #18 changed unnaturally his slant on the last sentence of the last session.

Size and Proportions

An overall increase in handwriting size was observed in the wall writings sample. To assess the influence of the writing conditions on proportions, a quantitative study was carried out on letters "h", "p" and "y" on a sample of ten participants (Figure 8). It appeared that pro-

portions were constant within the same letters produced during the nine spray can writings. A greater within-writer variation was observed between the letters taken from the conventional material. The results of the comparison of proportions between spray paint and conventional writings from the same author were dependent on the letter. Concerning the letter "h", proportions decreased on the spray can writings for every participant. No particular trend was observed concerning letters "p" and "y". For some people, proportions decreased, for others they increased and for the rest of the participants proportions were similar between both writing conditions.

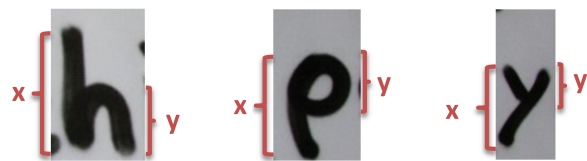


Figure 8. Proportions concerning letters "h", "p" and "y" have been obtained by calculating the ratio between y and x.

Shape and construction of letters

The amount of similarities between both writing conditions on shape and construction was strongly dependent on the writer. Some volunteers used different allographs of the same letter in different sessions of spray paint writing, while other participants were much more constant in their use of allographs. However, besides some exceptions presented here after, the writers used the same allographs in the spray paint writings and in the conventional material.

As seen above, people tended to slow their handwriting when using a spray paint can, yielding a more legible form of letters (Figure 2). Particularly, changes in letter shape (e.g. from arch to garland) were observed in five volunteers (e.g. Figure 9). This kind of variation was also mentioned by Junker and Köller (1997) on their study on the stability of handwriting under different conditions.



Figure 9. Volunteer #7 changed the letter "h" and "n" from an arch to a garland form, when using a different writing instrument.

A difference in the roundness of the shape of some letters was also observed for two volun-

teers. The form of the letter "L" became more angular on the spray paint writings of volunteer #9 (Figure 10). For volunteer #16 the opposite was observed for letter "v" (Figure 11).



Figure 10. Volunteer #9 form of the letter "L" became more angular on the spray paint writing.

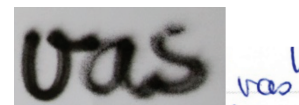


Figure 11. Volunteer #16 form of the letter "v" became more round on the spray paint writings.

For volunteer #22 in particular, several differences in shape were noticed between the writings made in different conditions (Figure 12).



Figure 12. Several differences in shape were observed between the spray paint and conventional writing samples for volunteer #22.

Beside the variations already presented, when dealing with construction, the videos highlighted stability between the ballpoint pen and the spray paint can writings for most of the participants. Stroke directions and loop construction (e.g. starting stroke position and orientation, loop direction) were preserved as well as some particularity of the conventional writing construction such as the final hook on the letter "y" shown in Figure 13.

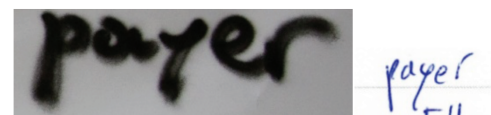


Figure 13. Volunteer #10 preserved the final hook of the letter "y" used in conventional writing when writing with the spray paint can.

A tendency to even add some strokes (e.g. the ending stroke for the letter "n") was also noticed in one case (Figure 14). This seems to go against the wish of simplifying the handwriting when us-

ing a spray paint can as mentioned by Jasuja *et al.* (2014).



Figure 14. When writing with the spray paint can, volunteer #6 added a terminal ornamental stroke on the letter “n”.

The participant position (e.g. standing in front of a wall when writing either with a pen or a spray paint can), has been identified as a factor increasing the number of strokes used to construct a letter (Ellen 2005; Jasuja *et al.* 2014). However, the analysis of the pictures, originals and videos did not confirm this observation. Note that it would have been difficult to appreciate this kind of details without the help of the video recording.

In addition to these observed differences, it is important to mention that different features varied according to the way the can was handled. The line thickness indeed depends on the distance between the can and the paper, and the ability to use the spray paint can and the paint flow also influence the quality of the resulting stroke.

In some cases, the participant inability to use the can in a proper way resulted in incomplete strokes or letters (Figure 15) as previously mentioned by Jasuja *et al.* (2014).

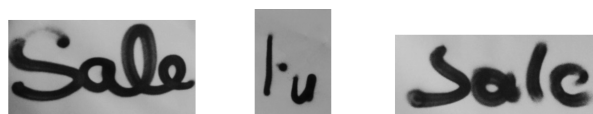


Figure 15. Examples of incomplete letters “S” from volunteer #3, “t” from volunteer #4, and “e” from volunteer #10.

In those cases, some volunteers decided to adjust the letter form by retouching it. This modification can be indistinguishable when observed with a naked eye due to the color and thickness of the stroke (Figure 16), or easily visible (Figure 17). In cases of rewriting, the resulting letter appeared thicker.

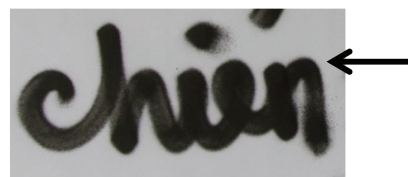


Figure 16. Indistinguishable retouching on the letter “n” indicated by the arrow and observed on the video recording (volunteer #13).

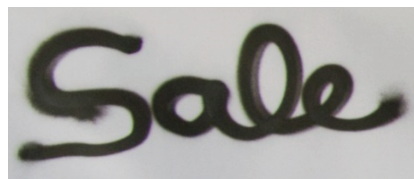


Figure 17. Visible retouching on the upper loop of the “S” (volunteer 3).

Connections

Various connection patterns were present between different walls writing sessions for a same volunteer and only some of them corresponded to their conventional writing (Figure 18). According to the participants’ comments, this discrepancy could be explained by the manipulation of the spray paint can. For some volunteers, writing vertically and applying a constant pressure on the can was exhausting, therefore connections were limited to relax the tension on fingers (Figure 19). For others, connections were increased in order to apply a constant pressure to the can all along a word and diminish the effort requested to activate again the spraying (Figure 20). In examining felt-tip pen writing on a balloon, Kelly (1978) already mentioned a tendency for people to introduce new characteristics in writings in order to increase their comfort.

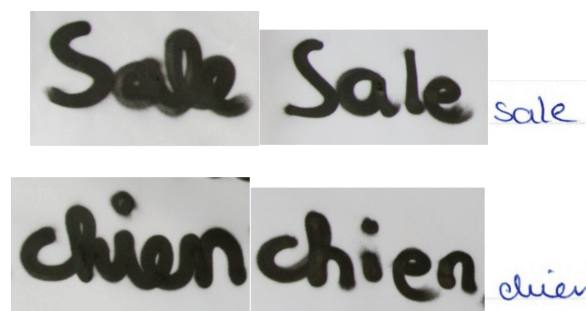


Figure 18. Depending on the session, volunteer #7 either added or reduced connections resulting in a style change.

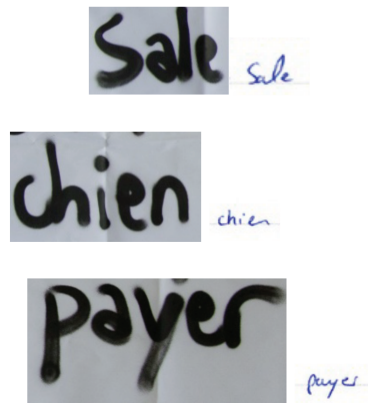


Figure 19. Volunteer #2 decreased the number of connections when writing on the wall.

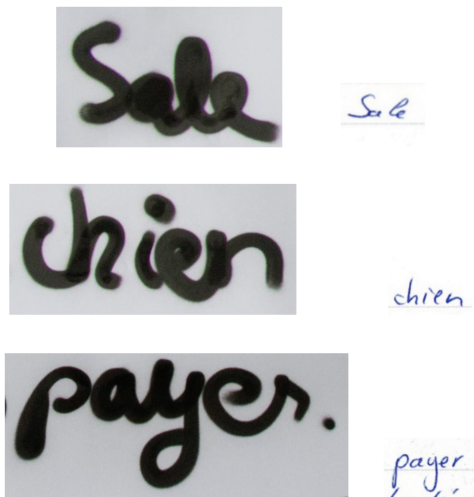


Figure 20. Volunteer #6 increased the number of connections when writing on the wall.

Use of diacritics

Given that the sentences were dictated by the researcher, some participants felt free to add some diacritics when needed. Volunteers #22, #23, #25 and #26 added an exclamation mark at the end of each sentence. Volunteers #3 and #13 added a coma after the word "chien" and one exclamation mark (volunteer #13) or three (volunteer #3) at the end of the sentence. Volunteers #6 and #21 ended their sentences with a point. Depending on the session, volunteer #7 added either a coma and a final exclamation point or only a final point to his sentences. These features could not be compared with conventional written samples, since those were copied from a printed text.

In the spray paint writings, the dot of the "i" of the word "chien" was generally made with a punctual pressure on the spray can, resulting in

well round dots. This shape was observed whatever the shape of the dot on the conventional writings, being round or made of a short straight line as in volunteer #27 (Figure 21). This might to some extent be explained by a higher speed when writing in conventional conditions.

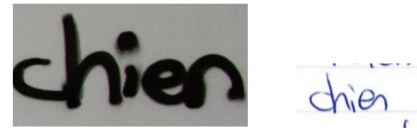


Figure 21. Volunteer #27 used a round dot in the spray can writings, and sometimes used a descending line in the conventional writing.

Discussion and conclusion

The aim of this research was to establish whether conventional reference material (e.g. executed with a ballpoint pen on a paper placed horizontally) is suitable for comparison when dealing with spray paint wall writings. In order to answer this question, writings on vertical surfaces and conventional reference material were collected for 27 volunteers. The samples collected under both writing conditions were separately analyzed and compared visually for each volunteer.

The comparison results of handwriting characteristics between regular and vertical spray paint samples have shown a strong dependence on the participant. For some volunteers most of the examined features were similar between the samples written under both writing conditions, while for others major discordances have been highlighted. Generally, the most stable features appeared to be the style and construction of letters. Concerning the shape, differences going from a more legible text to a change in the angularity of the writings (e.g. more curved/angular, from arch to garland) and an addition of embellishment or difference in the general appearance have been observed for several participants.

Connections, spacing, slant, size and proportions also varied between samples of a same writer. The pattern of connections varied for the same participant between different sessions of wall writings, and connections either increased or decreased when compared to the regular handwriting. On the writings with spray paint, spacing was either reduced or increased with no particular trend, slant was straightened up and size increased. Concerning proportions, a difference between the conventional handwriting sample and

the spray paint sample was observed for many participants, but no particular trend was detected. Furthermore, considering the emotional state of the individual writing on a wall, variations might be even more important. Stress, rage and the necessity to speed up the writing process, for not being caught in the act (Koppenhaver 2007) might add to the variations already mentioned.

A comparison of the wall writings between the different sessions did not show substantial variations among participants. Therefore, the writing of a given individual with spray paint on walls can be considered to be homogenous. Moreover, all the characteristics analyzed on the conventional samples written immediately after the sessions were not different from the ones of the reference text obtained later on. In other words, no particular influence of the spray paint can manipulation on the subsequent ball point pen writings was observed.

Due to discrepancies between writing samples produced under different conditions, and because no general variation pattern appeared to be common to every writer, we strongly advise to use reference handwriting samples that are written under similar conditions to those surrounding the questioned item. Of course, it may be difficult or sometimes impossible to collect adequate reference material. In such conditions, we invite handwriting examiners to consider the following scenarios, depending on the comparison findings. In particular cases where no difference is shown between a questioned spray paint text and conventional reference samples, the examiner may somehow support the proposition that the questioned text was written by the reference writer (rather than another unknown writer). However, in cases where differences are highlighted between a questioned spray paint text and conventional reference samples, the handwriting examiner may not know whether these differences are due to the influence of the writing conditions or to another writer. In such cases, reference material collected under similar conditions is mandatory.

The findings of this study help the forensic document examiner to recognize the spray paint writing features that can vary compared to conventional writings. Further research should investigate whether writings on walls vary significantly between people (between-writers variation), and if a questioned writing on a wall can be properly associated with its correct writer by forensic

handwriting examiners. This remains unstudied and will be dealt with in a next research project.

Bibliography

- Dreger A.(1997) Is it Authentic?. *Canadian Society of Forensic Science Journal*, 30(3): 97-104.
- Ellen D. (2005) Scientific examination of documents: methods and techniques. Boca Raton: CRC Press.
- ENFSI (2015) Best Practice Manual for the Forensic Examination of Handwriting.
- Equey C., Marquis R., Mazzela W.(2008) Influence of Writing Posture on the Dimensions of Signatures. *Journal of the American Society of Questioned Document Examiners*, 10: 53-59.
- Hilton O. (1984) Effects of writing instruments on handwriting details. *Journal of Forensic Sciences*, 29 (1): 80-86.
- Hilton O. (1992) Scientific examination of questioned documents. Boca Raton: CRC press.
- Huber R. and Headrick A. (1999) Handwriting Identification; Facts and Fundamentals, Boca Raton: CRC Press.
- Jasuja O., Singla A., Harzeen A. (2014) Spray paint writings on vertical surfaces executed by spray paint cans: a preliminary forensic study. *Problems of Forensic Sciences*, 98: 83-90.
- Junker A. and Köller N. (1997) Die Stabilität der habituellen Schreibweise unter ausgewählten Bedingungsvariationen. Presented at the third Internationaler Kongress der Gesellschaft für Forensische Schriftuntersuchung (GFS).
- Kelly J. (1978) An Unusual Writing Surface—and Considerations. *Journal of Police Science and Administration*, 6(3): 283-285.
- Koppenhaver K. (2007) Forensic document examination: principles and practice. Springer Science & Business Media.
- Locard E. (1940) *Traité de criminalistique*. Lyon: J. Desvignes.
- Marsh L. (2007) Some call it art: case studies investigating the spraying of illegal graffiti in the UK. Proceedings of the Trace Evidence Symposium, Clearwater Beach, Florida.

- Mathyer J. (1969) The Influence of Writing Instruments on Handwriting and Signatures. *The Journal of Criminal Law, Criminology, and Police Science*, 60: 102-112.
- Sciacca E., Langlois-Peter M., Gilhodes J., Margot P., Velay J. (2008) The range of handwriting variability under different writing conditions. *Journal of Forensic Document Examination*, 19: 3-13.
- Sciacca E., Langlois-Peter M., Margot P., Velay J. (2011) Effects of different postural conditions on handwriting variability. *Journal of Forensic Document Examination*, 21: 51-60.
- Thiéry A., Marquis R., Montani I. (2013) Statistical evaluation of the influence of writing postures on on-line signatures. Study of the impact of time. *Forensic Science International*, 230 (1): 107-116.
- Totty R. (1981) A Case of Handwriting on an Unusual Surface. *Journal of the Forensic Science Society*, 21(4): 349-350.

