

**AN EXAMINATION OF THE CHARACTERISTICS
OF DISGUISED AND TRACED HANDWRITING**

by

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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. In response this study has examined the principles and practices of two of the field's most complex areas of analysis: disguised and artificially assisted (traced) handwriting.

Any claims and observations made in the literature have been reviewed and empirically tested. A body of controlled data was collected from sixty volunteers who produced samples of disguised handwriting and traced signatures. A rigorous examination of these samples has been described and quantitative evidence found to support the conclusion that the act of disguising or tracing handwriting will have a negative influence upon the appearance and structure of that writing. Results have shown that disguised and traced writings are intimately related in that they share common characteristics that are indicative of the artificial manner by which they have been produced. Other features are also identified that can be directly associated with specific types of deviant writing to allow for distinctions to be made between them.

The analysis is expressed in the form of a comprehensive taxonomy of the distinctive features of deviant writing.

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Glossary of Terms

A

- Angular dimensions:** The slant or slope of individual letters, the slant of component parts of letters and the relative relationships that these measures may have to each other.
- Anonymous writing:** A letter, note or other communication in which the writer has concealed their identity by omitting their name or by using a pseudonym.
- Anticlockwise loop:** A loop formed with its stroke moving in an anticlockwise direction.
- Apex of letter:** Where two ascending or descending strokes meet to form a joint; often the highest part of a letter. E.g., ‘A’; ‘M’, etc.
- Arch:** The curved stroke emanating from a letter’s staff to form an arch or arches, e.g., ‘m’, ‘h’ and ‘n’.
- Arm:** A stroke projecting diagonally upwards from the staff, e.g., K.
- Artificial tremor:** A disguise technique whereby the writer introduces tremor into their disguised writing in an attempt to give the impression that the writer is ill, elderly, illiterate, or under the influence of alcohol or drugs.
- Ascender:** A stroke or part of a stroke that travels above the baseline.

Auto forgery: Genuine signatures that are written by the signatory but are deliberately disguised by them in order to deny authorship at some later time.

Axis line: A straight line drawn through a character's furthest two points.

B

Back slant: Where a letter or stroke leans backwards it possesses back slant.

Base of letter: The bottom of a letter, which may or may not coincide with the baseline of the writing.

Baseline: The positioning of letters in relation to a horizontal line, be it a visible printed line or an imaginary one.

Beginning stroke: First stroke of a letter or word.

Block lettering: The exclusive use of non-cursive, upper-case letters.

Blunt ends: The clubbed appearance at the beginning and ends of what should be freely made strokes.

Bowl: The rounded form of a letter formed by a curved stroke emanating from the staff. E.g., B, b, d, g, p, q, R, D, P

C

- Characteristic of deviant writing:** Observable feature in writing that occur accidentally as a consequence of the writer's deliberate alteration of their natural handwriting by means of disguise, tracing or simulation.
- Class characteristics:** Writing characteristics common to those who have learned the same system of writing.
- Clockwise loop:** A loop formed with its stroke moving in a clockwise direction.
- Connectors:** Strokes that link one letter or word to another. Also known as connecting strokes.
- Copybook writing:** The basic form of writing that is usually taught in childhood. The copybook refers to a book of model writing that is placed in front of the student for them to copy.
- Cross stroke:** A horizontal stroke that joins two strokes of a letter, as in A, H. A cross-stroke also is the horizontal stroke that completes a letter, such as J, E, F, T, f, t. This stroke is also known as a crossbar.
- Crossbar:** See entry for cross stroke.

D

- Degenerated line quality:** See under Line Quality.
- Descender:** A stroke or part of a stroke that travels below the baseline.

Deviant Writing: False writing that departs from naturally written writing in the way it was produced and which is made with the intent to deceive: by masking identity or attempting to make the writing or the document on which the writing is made to be accepted as genuine. Deviant writing incorporates disguised, traced and simulated writing.

Direct tracing method: The document that is to receive the traced signature is placed over a model signature. The outline of the signature is then traced directly onto the uppermost document.

Disguised writing: Handwriting that is deliberately modified to conceal the identity of the writer.

Down stroke: A stroke that descends towards the bottom of the paper.

E

Elevations: Vertical down and/or upstrokes of ‘U’; ‘u’; ‘Y’; ‘y’.

Ellipse: Oval.

End stroke: Last stroke of a letter or word.

Exemplars: Request or court ordered handwriting specimens (also known as standards) to obtain suitable samples of an individual’s handwriting.

Extraneous marks: Superfluous marks in the writing that are a by-product of the tracing or disguising process.

F

- Feathering:** See entry for Tapered Stroke.
- Feigned writing care:** An alteration of the degree of care habitually used by the writer in order to disguise their handwriting.
- Fine detail:** Small but important elements of a genuine writing.
- Flourish:** An embellished stroke or letter that is added to the signature for decorative purposes; often the most prominent feature of a signature.
- Flow back:** A characteristic specific to the fountain pen. Where two writing lines cross each other, the ink from the second line made flows back into the first. Similarly, if the pen is lifted and subsequently replaced onto a stroke already made, the ink from the new stroke will flow back into the first. Flow-back can also occur at the end of a stroke when the pen stops.
- Forgery:** In a strict sense, forgery is a legal term which implies an intent to deceive. However, for the purposes of this study, *forgery* will be used to denote any writing (usually a signature) that has been made by someone other than the genuine writer, whether it has been used for fraudulent purposes or not. Although disguised writing may be viewed as a special form of forgery, it is not so classed here, since a disguised writing is altered by the genuine writer for the purposes of concealing their identity.
- Forgery characteristics:** The distinctive features inherent in handwritten forgeries that can betray them as such.

- Form features:** A number of elements combine to form the pictorial quality of the writing. These include: slant, proportion, the connecting strokes that link individual letters and words, and the stroke sequences that are used to construct the letters.
- Fraudulent handwriting:** Handwriting made with the intent to deceive.
- Freehand imitation:** A copy of a genuine signature that is produced with the hand alone, with no mechanical or physical assistance. A freehand imitation attempts to replicate the genuine signature, as closely as possible in size and shape, so as to be mistaken for it. Freehand imitation is also known as freehand simulation.
- Freehand simulation:** See Freehand Imitation above.

G

- Graffiti:** Casual writing that has been made in a public place on a wall or other surface.
- Graphic maturity:** The degree of maturity of a person's writing which is dependent upon age, physiology and experience. This term was defined by R.N. Morris (2000, p.8).
- Grotesque writing:** Letter forms that are produced in a fantastic or distorted manner.

H

- Handprinting:** The use of various types of non-cursive or disconnected lettering systems.

Hesitation: Marks of hesitation, where the pen has been paused on the paper.

Hook: Small curved stroke at beginning and ends of strokes. E.g., insert 'g', 'j', 'y'.

I

Indented guidelines: Indentations in the paper, constructed by the forger to guide the direction of their pen. Indented guidelines are made by placing a model signature on top of the fraudulent document at the exact location in which the traced forgery is to appear. The forger traces over the model signature with a sharp implement and with a heavy pen pressure. The subsequent indentations are traced over in ink to complete the forgery.

Indirect tracing method: Indirect or two-step tracing describes any method of traced forgery which entails more than a single process to effect a counterfeit signature. Guidelines are used to aid the construction of the forgery.

Individual characteristics: Writing characteristics that are individual to each writer. Individual characteristics deviate from the copybook norm.

Infra-linear letters: Letters having lower projections below the x-height.

Initial stroke: The very first stroke that is made in a signature.

Inter-word spacing: The lateral spacing between words.

Intra-word spacing: The lateral spacing within words.

L

- Lateral expansion:** The definition by Huber & Headrick has been used in this work. They state that lateral expansion is, ‘the horizontal dimension of writing produced by the width of letters, the space between letters and words, and the width of margins’.
- Leg:** A stroke projecting diagonally downwards from the staff, e.g. ‘R’.
- Letters of benevolence:** Anonymous communications that are intended to aid the recipient in some way.
- Line direction:** The directional movement of the line.
- Line quality:** The evenness of the ink line. Its smoothness or otherwise will be affected by the speed and rhythm by which the writing was executed. The degenerated or poor line quality that is characteristic of a freehand-simulated signature will display a combination of tremor, pen lift, hesitation, overwriting and retouching.
- Linear dimensions:** Are those relating to all vertical, horizontal and diagonal measurements, which can be made with a single linear rule. The term also encompasses the relationships between measurements a) which are made along the same axis, and/or b) a comparison of two measures along different axes, i.e. vertical and horizontal.
- Linear letters:** Also referred to as mid-zone letters, this term refers to those lower case letters that have no components extending above or below the x-height. e.g., ‘e’, ‘c’, ‘a’, ‘s’.

- Loop:** A circular or oval character formed by a single stroke curving around and crossing itself.
- Lower projection:** A stroke descending below the body or x-height of a letter.
- Lower-case letters:** The small letters of an alphabet.
- Lower-case printing:** Handprinting that is made entirely of disconnected lower-case letters.

M

- Manuscript printing:** Disconnected writing which combines upper and lower-case letters.
- Mechanical tracing:** Tracings that are made using mechanical aids such as a Cameral Lucida or Pantograph or by using equipment such as photocopiers, scanners and printers.
- Method of disguise:** The manner or means by which the writer introduces changes into their natural handwriting.
- Mid-zone:** Those lowercase letters having no components extending above or below the x-height. e.g., 'e', 'c', 'a', 's'. Such letters are also referred to as linear letters.
- Mid-zone height:** The average size of the mid-zone or linear letters.
- Mirror writing:** A disguise technique whereby western writing would be made from right to left with the letter forms and order of letters reversed. If a mirror is then held up to the writing, the reflected writing will be reversed again so that it will be possible to read it normally from right to left.

Model signature: A genuine signature that is used to make a traced or freehand simulation. Model signature is also referred to as the target signature.

N

Natural Variation: The natural differences and combination of differences in writing features that occur in and between an individual's writing. These discriminating elements are habitual to the writer and can be used to differentiate their writing from other texts. A writer's natural variation will generally fall within a defined range for that writer. It is only by a comparison of a writer's natural variation that deviant writing can be identified.

Non-Dominant hand: The opposite hand than which is usually used by the writer to accomplish their writing.

O

Ornamented writing: Letter forms that are altered by the addition of superfluous ornamentations such as loops or curls.

Overwriting: An entire retracing of letters or words in an effort to improve the overall appearance of the writing.

P

Pencil guideline technique: An indirect method of tracing whereby the forgery places the document on which the tracing is to appear over the model

signature and traces its outline in pencil. This guideline is subsequently drawn over in ink.

Pen pressure:

The involuntary or unconscious pressure applied to the writing instrument, which produces a light, medium or heavy stroke in the writing line.

Pen-lift:

Indications in the written line that the pen has been lifted from and returned to the paper. Evidence of fraudulent pen-lift will invariably be found in unnatural places, where their presence interrupts what would normally be a continuous flow of writing in the genuine signature.

Pin prick guidelines:

A genuine signature is placed on top of the document that is to receive the forged signature. The forger then pushes a pin through the outline of the signature to create tiny holes on the document below. A pen is then used to follow the pin pricks to create the illusion of a genuine signature.

Poison pen letter:

Anonymous and disturbing communications typically written out of violent emotion and intended to provoke acute misery in the minds of its recipients.

Printscript:

A combination of manuscript printing and cursive writing. The majority of letters are printed, but some letters are joined with connecting strokes.

Q

Qualitative analysis:

An analysis of the written line, e.g. the formation of written strokes and the overall form of the writing.

Quantitative analysis: The analysis of the linear and angular measurements of a questioned writing.

R

Ratio: The relative relationship between a letter's vertical measurement (height) and its horizontal measurement (width).

Relative height: The relative relationships of height between and within individual letters.

Relative slant: The relative relationships of slant within and between individual letters and connecting strokes.

Relative spacing: Includes the a) inter-word spacing, b) intra-word spacing, and c) the average vertical height or depth of the questioned writing above or below the baseline

Retouching: An attempt to repair certain small areas of a forgery. Small delicate patchings are made at various points within the writing and certain strokes may be retraced. This is done in an attempt to improve general appearance and to give the illusion of smoothly flowing and, therefore, genuine writing.

Reversed slant: Where the forger reverses the slant of the strokes displayed in the genuine writing.

S

- Self disguise:** When an individual disguises their signature or signs a fictitious signature. See also Auto Forgery and Spurious Signature.
- Shading:** Where the variation in the width of the strokes is affected by the amount of pressure that is applied to the pen consciously or unconsciously.
- Slant:** The angle of the axis of letters in relation to the perpendicular of the baseline of the writing. Slant may also be referred to as slope.
- Slope:** See entry for Slant.
- Special characters:** Diacritics and punctuation marks, e.g. ‘i’ dot and full-stop.
- Spine:** The curved stroke forming the ‘backbone’ of the letter ‘s’.
- Spurious signature:** A forgery of another’s signature but with no attempt to copy the outline of the genuine signature or simulate the way in which the signatory actually wrote.
- Staff:** The main vertical stroke which forms the ‘backbone’ of a letter to which all other strokes (or limbs) are connected. The staff is also referred to as a stem.
- Standard:** Authentic samples of an individual’s handwriting which are used by the handwriting practitioner to examine the habits and idiosyncrasies of their penmanship.
- Stroke:** Any individual line made by the pen to form a letter or part of a letter.

- Superimposition:** When placed in juxtaposition, the model writing and traced forgery coincide almost exactly. Superimposition is also referred to as exact duplication.
- Superior simulation:** When a freehand-simulated signature is of superior quality in some way to the model it copies. Typically this will occur when a person of low graphic maturity has produced the model and when the simulator possesses writing skills, which are superior to that of the original writer.
- Supra-linear letters:** Letters having upper projections above the x-height.

T

- Tapered stroke:** Fine or tapered strokes are those where the ink line trails away and narrows to a fine point. Tapered strokes are features of unrestrained, natural writing, where the pen will be in motion before it touches the paper and continue to move as it leaves the paper. This characteristic is indicative of writing speed and continuity. Sometimes known as feathering or flying starts and flying finishes.
- Target signature:** A genuine signature that is used to make a traced or freehand simulation. Also known as the model signature.
- Terminal stroke:** Last stroke of the signature.
- Tick marks:** Short strokes, often angular in appearance, which are unconsciously made at the beginning or the end of strokes and are often characteristic to the writer.

- Traced writing:** The outline of a genuine writing, typically a signature. A tracing is made by means of a direct or indirect tracing process.
- Transference technique:** Carbon or tracing paper is used to create guidelines to make a tracing.
- Tremor:** Deterioration in the written line in the form of very fine oscillations. Tremor will tend to result when the writing is executed slowly.
- Trough:** The curve or valley at the bottom of two elevations in such letters as ‘u’, ‘y’, ‘w’.

U

- Up strokes:** Strokes that ascend towards the top of the paper.
- Upper projection:** A stroke extending above the body or x-height of a letter.
- Upper-case letters:** The large letters of an alphabet.

V

- Vertical stroke:** A stroke that is upright and perpendicular to the baseline of the writing.
- Visual feedback:** The forger’s reliance upon visual input to provide him with the information he needs to copy a model signature. Their eye will necessarily move from the model signature to the

copy to refresh their memory as to the overall form of the model.

W

- Writing line:** The writing line or ink line is the visible record of the movement of the pen.
- Writing movement:** A term which encompasses the writer's pen hold, speed of writing, and skill in writing.

X

- X-height:** Lower case letters having no ascending or descending strokes which extend above the body of the letter, e.g., 'e', 'c', 'a', 's'. Also referred to as mid-zone letters.

Z

- Zonal proportions:** The three zones of writing which are often used as an aid to teach children how to write. Writing is divided into three sections by the drawing of four horizontal lines, into which each letter of the alphabet is written. The top section is the upper-zone, the middle section is the mid-zone and the bottom section is called the lower-zone.

INTRODUCTION

‘Nothing,’ declared Robert Louis Stevenson (1889), ‘can be more interesting than the study of signatures, written (as they are) before meals and after, during indigestion and intoxication; written when the signer is trembling for the life of his child or has come from winning the Derby [...]. To the vulgar, these seem never the same; but to the expert, the bank clerk, or the lithographer, they are constant quantities, and as recognizable as the North Star to the night-watch on deck’ (Stevenson and Osbourne, pp.87-88).

The conviction that there is in each handwriting a ‘sacred something’ (Zinnel, 1931, p.18) which makes it sufficiently characteristic to allow it to be identified is one that has long been shared by the layman and the handwriting examiner alike, and is a belief that has been applied as equally to a single signature as it has to lengthier written texts. ‘A handwriting,’ wrote George Zinnel, ‘identifies but ONE individual mortal in the Universe’ (p.12). Distinctive features, habitual to the writer, are said to identify the handwriting, not only in the sense that a specific person can be recognized as being the author of a specific writing, but also in that a handwriting can be identified as something other than it purports to be. Given sufficient samples of comparable questioned and known handwriting samples, a disguised writing, Ames states, can be ‘easily penetrated’ and the writer ‘will be as inevitably manifest as he himself would be through any disguise of his person’ (1901, pp.93-94).

For over three hundred yearsⁱ ‘specially-qualified’ witnesses and experts in handwriting identification have testified in British courts of law (Risinger et al., 1989, p.755), although the practice of handwriting identification can lay claim to an even longer history. Under the Roman Constitution ‘experts charged with the comparison of handwriting’ were permitted to provide evidence relating to their examination (Code of Justinian, Order 49, title iv, ch.ii).ⁱⁱ But it was not until 1854, with section 27 of the Common Law Procedure Act, that evidence derived from a direct comparison of a questioned writing with examples of known or verified handwriting was formally admitted into the English courts (Risinger, Denbeaux and Saks, 1989, p.757).ⁱⁱⁱ

Regardless of the fact that their skill is said to be of a more practical nature than a scientific one¹, handwriting experts have allied themselves with a sub-branch of the forensic sciences, forensic identification, which includes, for example, fingerprint and firearms identification (Saks, 1994, p.427).^{iv} Under this banner, handwriting testimony has been largely successful in the courts of law; indeed, forensic handwriting identification has made important contributions to the judicial systems of Europe and North America, and it is not uncommon for Civil and Criminal cases to be decided largely or completely on the basis of the testimony of a handwriting expert.^v

But in spite of the fact that handwriting analysis evidence has had a long history of use and acceptance in the courts of Britain and the United States, this is not, an American Circuit judge recently insisted, sufficient to demonstrate its reliability.² This opinion is by no

¹ *United States v. Starzecpyzel*, 880 F. Supp. 1027, 1050-51, app. I (S.D.N.Y.) 1995.

² *United States v. Crisp*, United States Court of Appeals for the 4th Circuit, No. 01-4953 (CR-01-236) March 31, 2003, p.16. Judge Michael forcefully dissented from the majority’s opinion to admit handwriting and fingerprint testimony.

means a new one. Calls have been made from as early as 1879 for the practices and principles of handwriting analysis to become more scientific in approach. In anticipation of later critics, R.U. Piper (1879) declared that he objected ‘entirely to those persons being called experts in any case who have not prepared themselves to give scientific testimony (in the full meaning of the word science, e.g., knowledge certain and evident’ (p.282). Persifor Fraser (1894) added that expert testimony should ‘be defined by law to be such testimony as rests upon the application of principles (which are susceptible of explanation [...] by means of reasoning’ (pp.12-13). Similar sentiments have been echoed more recently and more forcefully in the United States, where attacks have been made on the legitimacy of forensic handwriting comparison as a whole and questions raised about the reliability of its methods and its adherence to scientific rigor. In consequence, serious doubts continue to be raised about the credibility of the entire discipline.

In an article published in *The University of Pennsylvania Law Review*, Risinger, Denbeaux and Saks (1989, hereafter Risinger et al.) examined all available published and unpublished handwriting analysis proficiency tests^{vi} and discussed what they saw as the ‘fundamental weaknesses’ of the principles and practices governing the discipline (p.759). Somewhat scathingly, they concluded that ‘the kindest statement we can make is that no available evidence demonstrates the existence of handwriting identification expertise.’ The ‘claimed skills and techniques’ (p.738) of handwriting experts, they imply, are based merely on historically asserted generalities rather than on empirically validated facts (pp.768-769). Such ‘inherited expertise’ (p.781), they maintain, is rooted in little more than mystical faith, and they consider it not so very far-fetched to draw a comparison between the modern day handwriting expert and the witch-finder of the fifteenth century (p.733).

Following in the wake of the Law Review's article came the *Daubert* or *evidence trilogy*: a series of landmark decisions made by the U.S. Supreme Court during the 1990's in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*,³ *General Electric Co. v. Joiner*⁴ and *Kumho Tire Co. v. Carmichael*.⁵ These three decisions represented a fundamental shift in the way that expert evidence was assessed by the North American judicial system. It rejected traditional standards for determining the admissibility of scientific expert testimony which had been in place since 1923,^{vii} and laid down more stringent criteria against which such evidence should be evaluated. *Daubert* gave the presiding judge the function of 'gatekeeper' as a means for establishing the reliability and the relevance of the principles underlying expert evidence alleged to be 'scientific'. In this Janus-like role, the judge was required, prior to a main trial, to apply four key questions to the expert evidence under consideration: (1) has the theory or technique been empirically tested (by means of generating hypotheses and testing them to see if they can be falsified), (2) has the theory or technique been subjected to peer review and publication, (3) has the technique a known or potential rate of error, (4) has the theory or technique had general acceptance within a relevant scientific community⁶. The decisions made in the subsequent court cases of *General Electric* and *Kumho* served to reinforce and expand the *Daubert* factors, thereby clarifying the standard for admitting expert testimony under Rule 702 of the Federal Rules of Evidence.^{viii} *Daubert's* focus was 'solely on the relevance and reliability of [...] principles and methodology,'⁷ whereas *Joiner* addressed the 'analytical gap'⁸ that may sometimes exist between the conclusion offered by the expert and the theories and practices that informed that conclusion. To avoid 'unsupported speculation,' it was held

³ 509 U.S.579, 1993.

⁴ 522 U.S. 136, 118 S Ct 512, 1997.

⁵ 526 U.S.137, 1999.

⁶ 509 U.S. at 593-94, 1993.

⁷ 509 U.S. at 595, 1993.

⁸ 522 U.S. 136, 146, 1997.

that experts must not simply defend their methodologies, as laid down by *Daubert*, but must also clearly demonstrate that their ultimate opinions were developed rationally and logically from them. In recognizing that the ‘conclusion and methodology are not entirely distinct from one another,’⁹ *Joiner* acknowledged that even though the methodology may fulfil the *Daubert* stricture of being ‘relevant and reliable,’ it may not adequately support the conclusion ultimately proffered by the expert; in such instances the expert’s evidence should be deemed inadmissible (Wecht, C.H and Rago, J.T., 2006, p.289).^{ix}

The *Daubert* decision was specifically limited to ‘scientific’ testimony¹⁰ and consequently it has sometimes been held that the expertise of handwriting experts cannot be challenged under *Daubert* since it constitutes practical, rather than scientific, knowledge:

[T]he testimony at the *Daubert* hearing firmly established that forensic document examination, despite the existence of a certification program, professional journals and other trappings of science, cannot, after *Daubert*, be regarded as ‘scientific [...] knowledge.’¹¹

The *Daubert* test for determining admissibility was, however, broadened, in the case of *Kumho Tire Co. v. Carmichael* in 1999, to include all specialized expert testimony, including that which is non-scientific or technical.^x This extension of what should and

⁹ 522 U.S. at 146, 1997.

¹⁰ 509 U.S. at 590, n.8 113 S.Ct. 2786, 1993.

¹¹ *U.S. v. Starzecpyzel*, 880 F. Supp. 1027, 1038 (S.D.N.Y.) 1995.

should not be admitted as evidence, and the greater reliance that the evidence trilogy placed on the scientific method, has had profound implications for forensic evidence in general and for the field of forensic handwriting analysis in particular. In the courts and in print, scrutiny of the forensic identification sciences has become ‘razor sharp and appropriately microscopic in nature’ (Pyrek, 2007, p.2). The trilogy has opened the door to a myriad of *Daubert* challenges critical of the field of handwriting analysis. Such challenges have often resulted in the limitation or exclusion of the testimony of handwriting experts^{xi} on the grounds that the discipline ‘does not rest on carefully articulated postulates, does not employ rigorous methodology and has not convincingly documented the accuracy of its determinations.’¹² Detractors of handwriting analysis contend that those within the profession rely entirely on intuition and subjective probabilities (Saks, 1994, p.433) and that they ‘have failed to engage in any critical study of the basic principles and methods of handwriting analysis, and few objective outsiders have taken on this challenge.’¹³ Its venerable status as the ‘oldest forensic science’ (Risinger and Saks, 1996, p.23)^{xii} does not, any more, provide an assurance or a measure of reliability. ‘Some forensic sciences have been with us for so long’, critics complain, ‘and judges have developed such faith in them, that they are admitted even if they fail to meet minimal standards under *Daubert*. Faith, not science, has informed this gatekeeping’ (Moriarty and Saks 2005, p.28). Forensic Handwriting analysis, these commentators imply, ‘constitutes precisely the sort of junk science that *Daubert* addressed.’¹⁴

¹² *U.S. v. Starzecpyzel*, 880 F. Supp. at 1028, 1995. In this case, handwriting evidence was admitted after the *Daubert* factors were deemed inapplicable to the testimony of handwriting examiners as their expertise was considered to be practical and not scientific.

¹³ *United States v. Crisp*, 324 F.3d 261 (4th Cir.), cert. denied, 540 U.S. 888, 2003, p.27.

¹⁴ 880 F. Supp. at 1028, 1995. Having admitted handwriting evidence, the court contended that had the *Daubert* factors applied it ‘might well have concluded that forensic document examination constitutes precisely the sort of junk science that *Daubert* addressed’.

The criticisms levelled at the field of handwriting analysis, particularly the sceptical assertions made by Risinger et al, have provoked irritation amongst some in the profession. Moenssens (1999) complained that the authors of the article in the 1989 *Pennsylvania Law Review* were unprofessional and ‘vengeful advocates in a vendetta war that they decided to wage against the prosecution and crime laboratories generally and document examiners in particular’ and that their opinions ‘were expressed in a sarcastic manner, in demeaning and deprecating language’ (Moenssens, 1999). But as harsh and uncomfortable as some of the indictments are, a review of the literature reveals that these are frequently justified. Zinnel (1931) wrote with zeal about the examination of handwriting, expressing himself in terms that were more akin to a mystically inclined devotee of the discipline than to an impartial observer. With obvious reverence for the subject, manifest in his capitalization of the noun, Zinnel (1931) comments, somewhat vaguely, about one of the basic tenets of handwriting analysis: the uniqueness of an individual’s handwriting:

I fail to find a descriptive name for it, so I will use the name ‘Something’ in describing it. This peculiar and marked ‘Something’ in people’s Handwriting seems to be undefinable [sic] and cannot be fully described in words. It may be one of the mysteries of this life, or we might say that a style of Handwriting is ‘Sacred’ to the person possessing it. It has never before been written by anybody else, and cannot now be written by anybody else, nor will it ever be written by anybody else in the future. Each style is strictly ‘SACRED’ to the person who writes it (p.18).

In a post-*Daubert* world, the ‘dogged certainty’ or *ipse dixit*¹⁵ pronouncements of its experts are insufficient to prove the quality and the reliability of forensic handwriting identification’s techniques and conclusions.^{xiii} Without any theoretical or empirical foundations to inform it, the evidence of handwriting experts can only, at best, be viewed as having been based on opinions that are sincerely held: at worst, it can be misleading, unreliable and prejudicial.

The legal ramifications of the North American evidence trilogy have been far-reaching. New Zealand now follows similar guidelines to those of *Daubert* (Great Britain. The Law Commission, 2009, p.30 § 4.26) and within the UK, following several notorious miscarriages of justice due to discredited forensic evidence, including *R v. Cannings*¹⁶ and *R v. Clark*,¹⁷ ripples of disquiet concerning the reliability of expert forensic evidence are beginning to be heard.^{xiv} In 2005, the House of Commons Science and Technology Committee overviewed the processes by which forensic science, a field in which they explicitly include document analysis, is used in the British criminal justice system (Great Britain. 2005, HC 96-1 and Great Britain. 2005, HC 96-II). ACPO (the Association of Chief Police Officers of England, Wales and Northern Ireland) in giving evidence to the Committee described the *Daubert* hearings as ‘an interesting development in seeking to establish that forensic evidence is soundly based before it is used in active cases’ (Great Britain. 2005, HC-96-II, Ev 201 § 13). Expressing concerns about the lack of an established protocol in this country for determining the admissibility of expert forensic evidence, the Committee stated that:

¹⁵ *General Electric Co. v. Joiner*, 522 US 136, at 519, 1997. ‘[N]othing in *Daubert* or the Federal Rules of Evidence requires a district court to admit opinion evidence which is connected to existing data only by the *ipse dixit* of the expert.’

¹⁶ *R v. Cannings* [2004] EWCA Crim 1; 1WLR 2607;

¹⁷ *R v. Clark* [2003] EWCA Crim 1020

[...] the idea of an objective, clearly defined test to establish whether a theory or technique is sufficiently robust and evidence-based to merit admission in court is highly attractive. The absence of an agreed protocol for the validation of scientific techniques prior to their being admitted in court is entirely unsatisfactory (Great Britain. HC-96-I, 2005, p.76 § 173).

The Committee concluded that a Forensic Science Advisory Council should be established to develop a ‘gate keeping’ test for expert evidence’ and recommended that this ‘should build on the U.S. Daubert test’ (Great Britain. HC-96-I, 2005, p.76, §173). The Committee’s recommendation followed a demand from Dr Chris Pamplin, editor of the UK Register of Expert Witnesses, ‘for our courts to formulate similar rules’ (Pamplin, 2004, p.1773)^{xv} to those laid down by *Daubert*. Redmayne (2001) also insists that the courts undeniably have an obligation ‘to make some inquiry into the soundness of expert evidence before it reaches the jury’ (p.125). Failure to impose a requirement of reliability as a condition of admissibility of expert evidence, he warns, will ultimately lead to further miscarriages of justice.^{xvi}

Indeed the scale of the problem was emphasized in a consultation paper published in April 2009 by The Law Commission of England and Wales, which was written as a contribution to the process of reform begun by the House of Commons’ Science and Technology Committee (Great Britain. HC-96-I, 2005, p.23, §3.17). The commissioners stated that recent miscarriages of justice owing to unreliable expert evidence may only be ‘the tip’ of a much larger iceberg (Great Britain. HC-96-I, 2005, p.14) and observed that:

The impact of wrongful convictions or acquittals is significant, extending far beyond the individuals directly concerned. It affects the shared interest of every citizen in having a fair and just criminal justice system (p.78).

Expert forensic evidence, the Commissioners assert, must be properly validated, if the public's confidence in the criminal justice system is to be retained (Great Britain. HC-96-I, 2005, p.82). This is all the more crucial in the light of the recent announcement made to MP's by James Brokenshire, the Parliamentary Under-Secretary responsible for crime reduction, that 'there will be no continuing state interest in a forensics provider by March 2012'.^{xvii} The closure of Britain's Forensic Science Service (FSS), the 'principal provider' of forensic services to the UK criminal justice system,^{xviii} means that all future forensic services, including those of forensic handwriting examination, will have to be supplied by the private sector alone: a change that some believe threatens the quality of forensic science provision in the UK (Prospect, 2010b). Mike Clancy, the Deputy General Secretary of Prospect, the main union representing FSS professionals, commented that the 'astounding' decision to break-up the FSS means that '[t]he government is putting its faith in an untested market to deliver forensic science at a time when it has never been more important to the detection of crime (Prospect, 2010a). Many consider Forensic science to be no less than 'a crucial underpinning of the entire criminal justice system, because it is a pillar supporting the heavy weight of democracy, and because it is a vital component of so many liberties and rights we have come to alternately expect, demand, and forfeit' (Pyrek, 2008, p.xvii); as such, the need for the development and implementation of methods and procedures that can ensure the reliability and validity of expert forensic evidence cannot be underestimated.

There are signs that the British civil and criminal justice systems are tentatively beginning to explore a validity-based admissibility framework (Pamplin, 2004, p.1773; Law Commission, 2009, p.46). Indeed, in both *R v Gilfoyle*¹⁸ and *R v Dallagher*,¹⁹ a ‘gate-keeping’ approach was employed for assessing the admissibility of expert evidence (Keane, 2008, p.539; Pamplin, 2004, p.1771), and in *Oldham Metropolitan Borough Council v GW & Ors* [2007],²⁰ Mr Justice Ryder commented that ‘there may be merit in considering the approach of the courts in the United States of America as derived from *Daubert v. Merrell Dow Pharmaceuticals Inc...*’ (para.100).^{xix}

These cases notwithstanding, the British judiciary have generally been hesitant to adopt *Daubert*-like admissibility tests (Keane, 2006, pp.125-126). But under provisional proposals made by The Law Commission and the subsequent publication of their recommendations for reforming the law relating to expert evidence in criminal proceedings (Great Britain. Law Commission, 2011), British judges may soon be obliged to undertake an ‘‘explicit gate-keeping’ role [...] with a clearly-defined test for determining whether proffered expert evidence [both scientific and non-scientific] is sufficiently reliable (that is, sufficiently trustworthy) to be admitted’ (Great Britain. Law Commission, 2009, p.49). In this way, the criminal courts will ‘have the means to authenticate expert evidence and be satisfied the information before them is sound’ (Great Britain. Law Commission, 2009).^{xx} In their Consultation Paper, the Commissioners explicitly place the testimony of handwriting examiners firmly in the category of ‘experience-based expert evidence’ (p.56), and propose that all such evidence should have applied to it a statutory three-stage admissibility test. This would examine the process by which the handwriting expert

¹⁸ *R v. Norman Gilfoyle* [2000] EWCA Crim 81.

¹⁹ *R v. Dallagher*, [2002] EWCA Crim 1903

²⁰ *Oldham Metropolitan Borough Council v. GW & Ors* [2007] EWHC 136 (Fam).

reached his or her opinion, the application of their methodology and, in line with *Joiner*,²¹ the reasoning underpinning the expert's conclusions (pp.57-58).

That scrutiny of the forensic identification sciences in general and handwriting analysis in particular is prevalent in the US and fast developing within the UK, is not, in the light of *Daubert* and the Law Commission's recommendations, surprising. But other factors may also have a bearing. Over recent years, the public's expectations of the forensic identification sciences have become unrealistically high in terms of the certainties that they can achieve. This is thought to be due in large part to the so-called 'CSI effect': the influence that forensic crime dramas are said to have on jurors (Pyrek, 2007, p.397). It is thought that exposure to such programmes as the popular American television crime drama *CSI: Crime Scene Investigation* has created in the public mind a false perception that forensic science has the ability and the technology to solve all crimes.^{xxi} If this is true, it could bring about a failure on the part of jurors to question the limits of forensic identification science, and may cause them to give undue weight to the evidence of its experts.^{xxii} If it is the case that jurors are placing a greater reliance on expert evidence to reach their verdicts, it is, then, all the more important for forensic identification evidence, including handwriting evidence, to be tested for reliability prior to its being admitted before a jury. In addition to the CSI effect, handwriting analysis also bears the responsibility of being 'one of the few forensic sciences which actually identifies the individual,' whereas other forensic sciences seek to establish links between people and places or objects (Giles, 2004, p.145). If the results of handwriting analysis can be so significant, it is to be expected that the evidential basis of the subject will be scrutinized

²¹ 522 U.S. at 146

intensively, both in the public and judicial sectors, and will continue to come under enormous pressure to prove scientifically that it can do what it says it can do.

But this should not be unwelcome. Notwithstanding the wrongful convictions due to unreliable forensic evidence mentioned above, forensic science, including handwriting identification, is still acknowledged in the UK as ‘a vital instrument for the detection of crime and the administration of justice,’ (Pyrek, 2005, p.5). Moreover, Forensic handwriting analysis continues to receive ‘broad acceptance’ in many of the law enforcement agencies²² in both the US and the UK. But the profession will have to act to maintain such recognition because, as it currently stands, handwriting analysis generally does not conform well to the standards of *Daubert*²³ or to the recent proposals made by the Law Commission. In his response to the Law Commission’s Consultation Paper (Great Britain. Law Commission, 2009), Associate Professor William O’Brian tacitly suggests that the evidence of handwriting experts is not sufficiently reliable because it does not have the foundations of good science behind it; or, at least, not yet. Handwriting analysis, he believes, is a method ‘that *could* be subjected to empirical testing [...]’ and therefore *should* be subjected to such tests before it is used as a basis for criminal convictions’ (Great Britain. Law Commission, 2011, p.52, italics added). If (as is envisaged) the Law Commission’s recommendations become law, then for handwriting analysis to remain a respectable member of the identification sciences, the principles upon which the field rests must be derived from *a posteriori* knowledge: from empirical facts rather than from skill- or experience-based observations, as has traditionally been the case. It is only by means of empirical data that reasonable expectations can be set with regard to what forensic

²² *US v. Prime*, 220 F. Supp.2d at 1215.

²³ *US v. Fujii*, 152 F. Supp. 2d 939, 940 (N.D. Ill.) 2000

handwriting examination can in reality achieve. This will increase the probative value of its evidence, whilst strengthening the reputation of the profession as a whole.

In response to the criticisms directed at forensic handwriting analysis, this research will examine the principles and practices of two of the field's most broad and complex areas of analysis: disguised handwriting and artificially assisted (traced) handwriting; deliberately deviant writing that is typically executed with the intent to deceive. Any claims and general observations made about deviant writing by handwriting examiners will be reviewed and empirically tested. The research will endeavour to determine to what extent it is possible to identify and record the characteristics of disguised and traced handwriting and to what extent it is possible to standardize the methodologies used to detect them.

The Law Commission recently stated that the reliability of a forensic document expert's testimony about the genuineness of a document should be determined 'on the basis of, amongst other things, the number of standard points of comparison used' (p.57)^{xxiii}. This research will therefore, seek to establish if it is, in fact, practicable to fix a standard minimum number of points of comparison for determining the authorship of a disguised or traced handwriting, and will also question whether the same can be achieved for positively determining that a particular written text has been artificially written.

The ultimate aim of this research is to establish if it is possible to obtain quantitative evidence that can be used to establish a systematic and comprehensive classification of the distinctive inherent features of deliberate deviant handwriting. The study will examine two common but problematical areas of forensic handwriting examination, disguised

handwriting and traced forgery, and will build significantly upon my M.Phil. thesis, *An Examination of the Characteristics of Freehand-Simulated Signatures*, which provided data to support the conclusion that handwritten simulations share common characteristics. In conjunction, it is intended that these studies will expand the corpus of knowledge, provide the legal community with the empirical data that they demand, and serve as a parameter by which the decisions of the handwriting practitioner may be guided.

PART I

Disguised Handwriting

1 DISGUISED HANDWRITING

Of the many complexities associated with the identification of handwriting, there is none more challenging than the ‘wilful transformation’ of writing (Sedyn, 1990, p.168). The problems that are said in the literature to be inherent in the detection of writing that has been deliberately disguised, such as the difficulty of its recognition, the complexity of identifying its author and the risk of wrongly attributing writing variations to disguise or the failure to recognize their significance, make it a topic, Webb (1978) exhorts, ‘worthy of frequent reconsideration by document examiners’ (p.149).

Certainly, there is much that has been written on the subject; ‘There is’, Webb exclaims, ‘hardly a book, a text or an article relating to handwriting identification that does not address the subject of disguise’ (p.149). But whilst there is a considerable body of literature that treats the issue of disguise generally, empirical research on the subject is comparatively limited and what studies there are tend to focus on the methods of disguising handwriting: those most frequently used by the would-be disguiser, the effectiveness of such methods and/or a consideration of the features of handwriting that are most frequently targeted for disguise. Few researchers have empirically addressed the question of whether there are features inherent in disguised handwriting that can distinguish it from a genuine writing or, moreover, from a simulated or traced forgery. The few that have explored this area do so only tentatively or incidentally as a consequence of their research into the methods of disguise.^{xxiv}

There is, moreover, a confusion that occurs frequently in the literature as to what constitutes a characteristic of disguise and what constitutes a method of disguise. Alford and Dick (1978) have spoken of the 'common features' indicative of disguise (p.421) but illustrate this with examples that more accurately refer to the methods used to produce a disguise, including the addition of embellishments to the writing or the introduction of grotesque letter forms. Similarly, in his examination of signature disguise, Herkt (1986) makes the observation that some of the writing characteristics that he categorized under methods of disguise may, in fact, have been due to the process of disguise: 'It is quite probable' he states, 'that some of the disguises described [...] resulted not as a deliberate attempt to use these features as a disguise, but as an unavoidable by-product of the overall effort of the disguises' (p.261).

In order to clarify what is meant by these terms, this research will consider characteristics of disguise as observable features in writing that have occurred accidentally as a consequence of the writer's deliberate alteration of their natural handwriting; a method will be defined as the nature of the change observed: the manner or means by which the writer introduces changes into their writing. An examination of the methods of disguise will be explored alongside the characteristics of disguise as it is proposed that a more positive determination of disguise will be achieved by the identification of both in any questioned document problems.

In order to evaluate the empirical evidence that exists on this complex subject and to assess the relative merits of any experientially based observations, a review of the literature will follow. For the purposes of clarity, the review will be completed in two parts. This chapter will present a general and historical background to the subject and will explore the

fundamental issues that are considered key to the question of disguise in handwriting: the problems that are associated with the examination and identification of a disguised writing, the reasons why disguise occurs, and the techniques that are used by writers to conceal their identity. Chapter 2 will examine the literature specifically relating to the characteristics that are thought to define disguised handwriting.

1.1 Disguise Defined

There is little disagreement in the literature that the term ‘disguise,’ as it relates to handwriting, is taken to mean a deliberate distortion or modification of an individual’s natural style of writing in an attempt to alter its appearance sufficiently to conceal the identity of its author (Harris, 1953, p.685; Baker, 1955, p.289; Hilton, 1982, p.168; Koppenhaver, 2002, p.24). Nevertheless, a clear distinction is not always drawn between writing that has been disguised and that which has been simulated or traced.^{xxv} Dines (1998) has defined disguised writing as that which has been ‘deliberately altered with the intention of *changing* the writer’s identity’ (p.51, italics added), and he later asserts that freehand simulations and traced forgeries can be viewed as ‘examples of almost perfect disguise’ (p.274). Inasmuch as a simulated or traced handwriting is effected deliberately, and the perpetrator’s natural handwriting characteristics will be modified to a greater or lesser degree depending upon their skill in adopting the writing style of another person, freehand simulation and traced forgery may, indeed, be viewed as types of disguise; but to regard simulated and traced writing as categories of disguise ignores the important distinction that sets disguised writing apart. To disguise one’s handwriting is not an attempt to adopt a different identity, as Dines implies in his definition, but is designed and effected

‘to hide the personality of the writer without assuming the characteristics of another’s writing’ (Robertson, 1991, pp.157-158).^{xxvi} Moreover, in order to produce a simulation or traced writing, the forger will have a pattern or model writing to guide them, whereas disguised writing is not reliant on a model to produce a handwriting that is sufficiently different from the writer’s own, but is dependent upon the writer’s power of memory, visual feedback and their general physical ability to execute the task.

Nickell (1996) uses the term ‘unintentional disguise’ to refer to those factors that can, given the right circumstances, change the pictorial appearance of handwriting naturally, such as illness or the infirmity of old age (p.50). But implicit in the term ‘disguise’ is the suggestion of something that has been effected consciously and intentionally. Although changes can certainly occur in the writing of the old or infirm to render it as almost unrecognizably different from what the writers would acknowledge is their normal style of writing, these changes will be, as Morris (2000) notes, beyond the writer’s control and will be made unintentionally and unavoidably (p.165). Since this study is concerned with the deliberate alteration of handwriting, ‘unintentional disguise’ will not be considered here further. Moreover, freehand simulations and traced forgeries have not been included under the category of disguise but are treated elsewhere under separate headings.^{xxvii}

1.2 Difficulties of Disguise

‘Disguise is no problem - if you recognize it’ (Bradford and Bradford, 1992, p.229). This seemingly casual observation serves to highlight the ‘peculiar problems’ (Harrison, 1962, p.752) that disguised handwriting can present to the document examiner as regards its

detection and the difficulties of identifying its writer. According to the literature, an incorrect determination of disguise will be made when:

- Consistent and subtle characteristic differences between a suspect and known writing are attributed to disguise, when in reality they are evidence of different writers. (Harrison, 1966, p.349; Ellen, 1997, p.51; Morris, 2000, p.166).
- Characteristic differences between writings are attributed to disguise but are due to other factors such as ill health, the influence of alcohol, or are due to external factors such as the writing surface or writing instrument. (Dines, 1998, p.136; Alford and Dick, 1978, p.421).

Conversely, a disguised handwriting may not be recognized if:

- Corresponding characteristic features between a questioned and known writing are dismissed as being the product of different writers when in fact they are indicative of disguise by one writer (Harrison, 1966, p.349).
- The indications of disguised writing are mistaken for the signs of slowness or for the writing of an individual with a low level writing skill (Morris, p.166).

That a positive determination of disguise can be problematic is borne out by Quirke's admitted difficulty in explaining how he arrives at the conclusion that writing is or is not disguised:

For this work one needs ripe experience, keen observation, and a specialized judgement - three qualities which can be acquired only at the expense of long practice. For the beginner it is of course, desirable to provide a general hint or two, but here I am frankly at a loss. I have never yet been asked in the witness box, how, and by what process I differentiate between what is characteristic in a partially disguised hand, and that which is artificial. Were such a query put to me, I should have considerable difficulty in explaining myself [...] (pp.78-79).

1.2.1 Examining the Historical Context of Disguise

In order to fully appreciate the problems of disguise, it is important to examine some notable cases where a determination of disguise has been of particular significance.

In his landmark work *Questioned Documents*, Osborn (1929) wrote that one of the ‘most important contributing causes of error in the identification of writing is the assumption that all the differences in two writings are the result of intended disguise. This wholly unwarranted assumption is often made, insisted upon, and followed’ (p.386). Some of the most notorious cases of miscarriage of justice have arisen where grave errors of judgement have led a handwriting expert to an incorrect determination of disguise, and none, perhaps, have been more infamous than the case of Adolf Beck and ‘L’Affaire Dreyfus’.

The Beck case of 1896 resulted in one of the great *causes-célèbres* of the twentieth century. An entirely erroneous conclusion of disguise, presented by the prosecution's handwriting expert, was to play a critical part in the 'grievous wrong' (Committee of Inquiry, 1904, in *The Times*, 1904c)^{xxviii} that befell Adolf Beck. This flawed judgement, coupled with other 'lamentable features'^{xxix} manifest in the criminal procedure at that time, led in 1907 to a reform of the administration of the English justice system with the creation of the Court of Criminal Appeal (Jackson and Spencer, 1989, p.201).

The events began in 1877 when John Smith was convicted at the Old Bailey for having defrauded several women out of money, jewellery and other personal possessions. Some years later, after being released from jail, Smith began another series of frauds which were 'identical both in method and detail' (Committee of Inquiry, 1904, in *The Times*, 1904b, p.9)^{xxx} to those which he had committed earlier; but it was the entirely innocent Adolf Beck who in 1895 was identified by one of the victims as being the man who had swindled her. 'Indignantly' protesting his innocence, Beck was arrested (Report of the Committee of Inquiry, 1904, cited in *The Times*, 1904e, p.6). After the case received publicity, other victims came forward to identify Beck as the swindler. Most damning of all an ex-police constable who had arrested John Smith in 1877 came forward and 'swore positively that Mr. Beck was Smith' (Report of the Committee of Inquiry, 1904, cited in *The Times*, 1904e, p.6). It seemed as if Adolf Beck's true identity was established beyond doubt and he was subsequently charged and committed for trial under the name of John Smith.

In both the Smith case of 1877 and in the Beck case of 1896 bogus cheques and handwritten lists had been written by the swindler and neither the prosecution nor the defence in Beck's trial disputed that the incriminating documents in both cases were in the

same handwriting; the counsel for the defence, Mr Gill, in his statement to the Committee of Inquiry, commented that this fact needed no discussion as ‘it was common ground that the handwriting was identical’ (reported in *The Times*, 1904b, p.9). In view of this, it was the intention of the defence to found their defence on the fact that Beck could not have written the documents in either case. Given that the incriminating documents in both trials contained identical handwriting, then it must follow that they were written by the same person; since there was ‘abundant evidence’ to prove that Beck could not have committed the first fraud (Report of the Committee of Inquiry, 1904, cited in *The Times*, 1904e)^{xxxii} then it must also follow that he could not have committed the second (Committee of Inquiry, 1904, in *The Times*, 1904b).^{xxxiii} In addition, ‘the handwriting on the [incriminating] documents was that of a man who could write with facility, and [...] Beck was a man who wrote with considerable difficulty and [...] his handwriting was very laboured’ (Committee of Inquiry, 1904, in *The Times*, 1904b, p.9).

Nevertheless, the handwriting expert for the prosecution, Thomas Henry Gurrin, testified that notwithstanding the dissimilarity between Beck’s admitted handwriting and the writing sent to the victims of 1896, it was his opinion that the incriminating documents had been written by Beck in a disguised hand (Committee of Inquiry, in *The Times*, 1904b, p.9).^{xxxiii} Yet evidence that showed ‘conclusively’ that the documents involved in both the 1877 trial and the 1895 trial ‘were the work of the same man’ was withheld from the jury, the Judge having decided that it was a matter irrelevant to the main issue (Report of the Committee of Inquiry, 1904, cited in *The Times*, 1904e).^{xxxiv} Adolf Beck was subsequently found guilty and sentenced to seven years of penal servitude. Clearly, a number of elements combined to place Beck in the unfortunate position in which he now found himself,^{xxxv} but it was the

evidence of the handwriting expert that played a crucial part in sealing his fate (Irving, 2008, p.9). Beck was to serve five years of his sentence and was released in 1901.

John Smith once more resumed his acts of deception, and once more it was the unfortunate Beck who was charged with his crimes. Gurrin, who was of the belief that ‘it was quite possible that a man might adhere to the same form of disguised handwriting for a large number of years’ and who was strongly influenced by a report from the Treasury stating that there was no doubt that the incriminating documents of 1877, 1896 and 1904 had all been written by one person, was content to repeat his testimony of 1896 (Report of the Committee of Inquiry, 1904, cited in *The Times*, 1904e)^{xxxvi} and to state that the 1904 documents had been written and ‘studiously disguised’ by Adolf Beck (Irving, 2008, p.30). For the second time, Beck was convicted for crimes he had not committed, but on this occasion, and immediately prior to his sentencing, the real ‘author of the crimes’ (Irving, 2008, p.32),^{xxxvii} John Smith, was fortuitously arrested and his guilt established ‘beyond a shadow of a doubt’ (*The Times*, 1909).^{xxxviii} Gurrin immediately withdrew his evidence unreservedly and would later state at the official inquiry into the Beck case that he ‘deeply regretted his error of judgement;’ Gurrin added, rather alarmingly, that if he had been aware that other evidence against Beck had been false, and had he known ‘that John Smith and Mr. Beck were two different persons, his report would have been in Mr Beck’s favour’ (Committee of Inquiry, 1904, in *The Times*, 1904a).^{xxxix}

George R. Simms, a renowned author, dramatist and popular columnist of his day, referred to Adolf Beck as ‘our English Dreyfus’ (cited by Maybrick, 1904, p.160),^{xl} and it is certainly true that strong parallels exist between the Beck trial and the Dreyfus Affair. As in the English trial, a wrongful determination of disguised handwriting had a decisive role

in deciding the outcome of the French prosecution. According to Melvyn Bragg, the Dreyfus Affair of 1894 ‘tore France apart [as it] threatened the foundations of the French Republic itself, provoked the separation of Church and State, and established the model of the French intellectual.’^{xli} On a wave of anti-Semitic hysteria, Alfred Dreyfus, a Jewish Captain in the French General Staff, was accused of passing secret military intelligence to the Germans. Court-martialled and subsequently convicted of High Treason, Dreyfus was deported to Devil’s Island where he was to serve a life sentence in solitary confinement. His conviction was based primarily on an unsigned, handwritten *bordereau* or memorandum, which provided detailed information on military technology and strategy. Handwriting experts were divided as to whether Dreyfus had, in fact, written the *bordereau*; M. Gobert, the official handwriting expert of the Bank of France and of the Court of Appeal, and the first specialist to compare the *bordereau* with Dreyfus’s known writing, concluded that ‘the lettre-missive in question may quite well have been written by another person than the one suspected’ (*The New York Times*, 1899b, p.2).^{xlii} Gobert had noticed certain similarities between the handwriting of the *bordereau* and that belonging to Dreyfus, but he had also found ‘many important differences which proved [...] that Dreyfus was not the author of the *bordereau*’ (*The New York Times*, 1899b, p.2). But keen that Dreyfus should be convicted, in part to protect the army’s honour,^{xliii} but also unquestionably because of strong anti-Jewish prejudice, the French military command instructed Alphonse Bertillon, Director of the Police Identification Services in Paris, to examine the documents. Considered by many to be ‘the prince of quacks’ (*The New York Times*, 1899b),^{xliv} Bertillon, himself a fierce anti-Semite,^{xlv} ‘had no training or true expertise in handwriting identification’ (Tilstone et al., 2006, p.123),^{xlvi} but he duly conducted an examination, albeit a subjective one,^{xlvii} and ultimately came to the conclusion that the General Staff had desired: Dreyfus was the author of the *bordereau*

(*The New York Times*, 1899b). In considering the question of why so many dissimilarities existed between the admitted writing of Dreyfus and that of the *bordereau*, Bertillon exclaimed, ‘why, he wants to be able to make out that his own writing has been traced [...] Dreyfus has combined a modified disguise of his own writing with an imitation of a forged document’ (Kayser, 2005, p.41). In the second Dreyfus trial, Bertillon would confound and amuse all who heard his labyrinthine explanations of the complicated system of handwriting examination he used.^{xlviii} An attempt to summarize Bertillon’s eccentric argument was made by Kayser (2005):

If Dreyfus is a traitor the *Bordereau* written by him must show both similarities and dissimilarities to his writing. The *Bordereau* contains some similarities and much dissimilarity; therefore Dreyfus is a traitor! (p.66).

In 1896, the French Intelligence Service came into possession of evidence that pointed the finger of suspicion firmly at another officer in the French army, Major Ferdinand Esterhazy. Public pressure demanded that Esterhazy be tried, but within one day the army had unanimously acquitted him (Sennett, 1977, p.240). Appalled at what he saw as a blatant miscarriage of justice, Emile Zola immediately published *J’Accuse*, his famous and impassioned open letter to the President of the French Republic (*L’Aurore*, 1898) in which he charged the handwriting experts who had testified against Dreyfus ‘of having submitted reports that were deceitful and fraudulent, unless a medical examination finds them to be suffering from a disease that impairs their eyesight and judgement’ (Zola, 1898).^{xlix} This inflammatory letter led to Zola’s subsequent trial for libel and in reporting the court proceedings, *The New York Times* (1898) quoted M. Frank, a lawyer and ‘amateur’ expert

in handwriting, who spoke of the initial examination in 1894 of the writing of the *bordereau*:

The majority of the experts started on the false idea that the writer of the *bordereau* had disguised his handwriting. The *bordereau*, however, was written naturally and in a running hand, which is identical with that of Major Esterhazy (*The New York Times*, 1898).

Moreover, in a dramatic turnaround at the Dreyfus's re-trial of 1899, one of the original handwriting experts for the prosecution in 1894, M. Charavay, who had himself denounced Dreyfus as the author of the *bordereau*, now stated that '[i]t is a great relief to my conscience to be able to say before you and before him who is the victim of my mistake that the *bordereau* is not the work of Dreyfus, but of Esterhazy' (*The New York Times*, 1899d). By this time Major Ferdinand Esterhazy had fled to England, where, somewhat surprisingly, he confessed to *The Observer* (1898)¹ that he was, indeed, the author of the infamous *bordereau* (Anstey and Silverlight, 1991, p.47; Lindemann, 1992, p.120). Dreyfus was subsequently pardoned 'in principle' in 1899 and finally exonerated in 1906; but it was not until 13 September, 1995 that the French army officially and publically admitted to the French Jewish Central Council that the Dreyfus affair had been 'a military conspiracy which led to the conviction and deportation of an innocent man, [...] partially on the basis of a falsified document' (*Associated Press*, 1995).

The Government Commissary prosecuting Dreyfus stated during the final trial that the handwritten *bordereau* constituted 'crushing evidence against the accused' (cited in

Kayser, 2005, p.69). On the contrary, it served merely to show the dangers that can occur when disparities between writings are too quickly dismissed as disguise.

1.3 Types of Disguise

The various purposes that are served by handwriting disguise are identified in the literature, and several explanations are offered for the motivation that lies behind such acts of deception. It is said that a person will deliberately try to disguise their writing to prevent them from being associated with, or being identified as, the author of a specific writing, such as anonymous letters, anonymous graffiti, or any incriminating documents, such as court-ordered handwriting samples, fictitious cheques or other official records. In addition, a person may disguise their own signature for the purposes of disclaiming it at some later date (Huber and Headrick, 1999, p.279; Dines, 1998, p.274; Hayes, 2006, p.161; Ellen, 1997, p.34).

The various types of disguise discussed below will be illustrated by examples taken from the long history of fraud in handwriting. Because the essentials of handwriting examination have not changed, examples from the past are still relevant today.

1.3.1 Anonymous Letters

For Blackburn and Caddell (1909) the anonymous letter is a 'mischievous and cowardly form of secret attack' and its writer 'the assassin of reputation and domestic happiness' (p.47). The 'curious phenomenon' (Rhodes, 1934, p.96) of anonymous writing may

involve a letter, note or other communication, but the writer will always conceal their identity by omitting their name or by using a pseudonym (Baker, 1955, p.283; Hayes, 2006, p.147). In addition, when anonymous letters are written by hand the writing will invariably be 'masked' (Downey, 1917, p.386).

Disguised writing will particularly be found in those anonymous communications concerning blackmail or ransom demands, but intriguingly, it will also be found in some anonymous graffiti (Dines, 1998, p.274, Robertson, 1991, p.238). By sending an anonymous communication, Robertson comments, the anonymous letter writer seeks 'to mislead, control or change situations and people while avoiding overt involvement with their victims' (p.238). For Gassiot and Moron (2002), the writing of anonymous letters is a complex pathological mechanism and is, they assert, always the manifestation of a disturbed psyche (p.311).

Throughout history, the anonymous letter writer or 'Crow'^{li} as the French have come to refer to such individuals, have plagued society with their words of venom and vitriolic vehemence, instilling fear and intimidation into their victims. In about A.D. 111 or 112, Pliny the Younger^{lii} referred to an anonymous letter in his correspondence with the Emperor Trajan (Pliny, *Epistulae* 10:96),^{liii} which he wrote when serving as the governor of Bithynia and Pontus in northern Asia Minor (Firth, 2004, p.7; Trapp, 2003, p.14). Pliny wrote of his perplexity at how best to deal with those individuals who were denounced as Christians:

An anonymous letter was sent, containing the names of many persons, who, however, denied that they were or had been Christians. As they invoked the gods and worshipped with wine and frankincense before your image, at the same time cursing Christ, I released them the more readily, as those who are really Christians cannot be got to do any of these things (Pliny, *Epistulae* 10:96).^{liv}

Trajan entirely approved of Pliny's conduct with regard to the Bithynian Christians (Pliny, *Epistulae* 10:96), but counselled wisely that:

No weight whatever should be attached to anonymous communications; they are no Roman way of dealing, and are altogether reprehensible (Pliny, *Epistulae* 10:96).^{lv}

Osborn (1946) and others revisit the most celebrated cases involving anonymous letters including the Junius letters, which were published in the London 'Public Advertiser', a popular newspaper of the time, between 1769 and 1772 (Osborn, p.126; Baker, 1955, p.289; Robertson, 1991, p.237). This series of disguised letters has been described as 'the most famous anonymous letters in all history' (Osborn, p.126), and will be read, Sir Nathaniel Wraxall (1845) commented, '[for] as long as the English language endures' (p.154). The acrimonious pen of Junius scurrilously and satirically attacked the most prominent political and social characters of the day (Osborn, p.126; Baker, 1955, pp.289-290) and took every opportunity to expose concealed corruption in political circles as well as in the courts; Junius drove the Prime minister to resign^{lvi} and did not even allow the

King^{lvii} to escape censure (Wraxall, 1845, p.154; Osborn, p.126; Baker, pp.289-290).^{lviii} The letters were, as Redman (1968) comments, not only elegantly written, but ‘acidly accurate and invariably irrefutable’ (p.113). But to write such scandalous revelations about individuals at the very highest levels of power would have ruinous and dangerous consequences for the author should he or, perhaps, she^{lix} be discovered (Ames, 1901, p.242). Accordingly, the letters of Junius were carefully written in a disguised hand ‘of fine quality’ (Baker, 1955, p.290). One hundred years after they first appeared, Charles Chabot (1871) published a detailed examination of the letters in a comprehensive attempt to identify their author. This expansive work was the first published book in English to provide a methodology for the work of the handwriting examiner (Blackburn and Caddell, 1909, p.78) and also the first to claim that a science of handwriting identification existed (Risenger and Saks 1996, p.25). Chabot concluded that Sir Philip Francis, a government official at the time, was the author of the Junius Letters. Frazer (1894) and Baker (1955), clearly impressed by his exhaustive examinations, agreed with his findings, but Osborn (1946) was disinclined to accept Chabot’s conclusion (p.128).^{lx} The mystery surrounding the authorship of the Junius Letters still remains, and has continued to be a matter for conjecture for over two hundred years.^{lxi}

But in this age of the digital revolution, with its prevalence of electronic communication, is it now possible to relegate the anonymous letter to the footnotes of history? A review of the newspapers and the internet suggests that physical anonymous communications continue to be sent even today, and such documents still make up a large part of a handwriting examiner’s caseload.^{lxii} Incredibly, there are even websites available to those who want to send anonymous and malicious communications to their ex-partners.^{lxiii}

Just why people continue to write such communications by hand remains difficult to explain; Sedyn (1990) believes that the answer to this lies in the fact that writing is not primarily a means of communication but ‘the result of a deeply rooted need.’ It is an act that is caused by ‘an internal necessity to expel intense feelings, conscious or unconscious: love and hate, greed for power, desire to destroy’ (p.166). Handwriting, she asserts, should be viewed as a distinct object, that consciously or unconsciously flows out from within the individual and may be considered an expression or exteriorization of the individual self (pp.166-167). Whether this is true or not, anonymous communications do appear to be born from intense human emotion: hatred, jealousy, envy, spite, anger, revenge, and sexual desire all serve as powerful motivators to the anonymous writer (Harrison, 1954, pp.343-347; Keown, 1994, p.690; Hayes, 1999, p.149).

Frequently, the anonymous letter writer will target prominent people or figures of authority, such as celebrities, elected officials, business leaders, teachers and religious figures (Keown, p.690). In 1844, in response to a pamphlet in which the Reverend William Lisle Bowles (1821) complained that he had received an anonymous letter, Lord Byron recommended that by far the best course of action was to ignore the unnamed writer either directly or indirectly. He continued by describing the numerous anonymous communications he had received:

I wish Mr. B. could see only one or two of the thousand which I have received in the course of a literary life, which, though begun early, has not yet extended to a third part of his existence as an author. I speak of *literary* life only; -were I to add *personal*, I might double the amount of anonymous letters. If he could see the violence, the threats, the absurdity

of the whole thing, he would laugh, and so should I, and thus be both gainers (cited in Moore, 1854, p.164).

It is claimed that in one out of every four or five cases, an anonymous letter will be addressed to the actual writer of the letter (Osborn, 1946, p.128; Huber and Headrick, 1999, pp.283-4; Brewster, 1932, p.110). Sometimes this will be done to gain sympathy from others, but more often than not it will be an attempt to divert attention and suspicion away from the author (Robertson, 1991, p.238).

Several types of anonymous letter are discussed in the literature, and these form the basis for the following categories:

1.3.1.1 Poison-Pen Letters

The term poison-pen is applied to those anonymous communications that cause acute misery to its recipients. Vicious, persistent and disturbing, the poison-pen letter, Brewster (1932) asserts, 'is one of the greatest ills of civilization, as it often causes intense agony and suffering among innocent persons, bitterness and estrangement between relatives and friends, and suspicion and distrust amongst whole communities or sections of society' (p.109). Because these letters will often concern sexual or other intimate relations, and are typically written out of violent emotion, they can provoke in the recipient a deep mental anguish which may ultimately lead to illness, divorce or suicide (Brewster, p.109; Robertson, 1991, p.239). The power of these letters to harm cannot be underestimated, Robertson believes, and in order to 'disarm' their impact, it is important that the writer is identified (p.239).

1.3.1.2 Letters of Benevolence

The Ladies' Repository of 1856 declared that '[a]nonymous letters may be very good in some times and places [...]' (p.70). It was, after all, they said, 'an anonymous letter that saved England from the Gunpowder treason and plot' (p.70).^{lxiv} The intention of an anonymous letter is not always to wound, but can sometimes be a sincere attempt by the writer to prevent danger, malpractice, misconduct or crime or to offer words of advice or comfort (Brewster, 1932, p.110; Baker, 1955, p.192; Robertson, 1991, p.239; Hayes, 2006, p.147). It is, suggests Brewster, the fear of reprisal, either physical or social, that prevents the beneficial writer from openly revealing their names (p.110).^{lxv} Altruists may also withhold their names to prevent their identity from being known in connection with any charitable contributions they make or endowments they choose to bestow (Baker, p.192; Robertson, p.239).

1.3.1.3 Letters and Notes as Part of the Commission of a Crime

Anonymous letters that are criminal in nature are those which are used for blackmail or extortion to deprive the victim of their money, property or autonomy. Extortion letters will attempt to intimidate their victims with some kind of credible threat, including, but not limited to, physical violence, death or kidnap, in an attempt to coerce them into carrying out the will of the writer (Hayes, p.149). Robertson comments that 'the most vicious of all extortion notes' (p.239) are ransom notes which demand money for the release of kidnapped victims.^{lxvi} Blackmail, which may be viewed, Leiser (2008) suggests, as a form of coercion, menaces its victims with the power of knowledge (p.31); the victim is threatened with imminent exposure of sensitive or confidential information about themselves if they fail to comply with the blackmailer's demands (Lamond, 1996, p.216).

1.3.2 Handwriting Exemplars

It is frequently the case that request or court ordered handwriting specimens (also known as exemplars or standards) will be disguised (Alford and Dick, 1978, p.421). Obtaining suitable and adequate samples of an individual's handwriting is often, Hayes (2006) states, 'the most important factor in formulating correct opinions in questioned document cases' (p.103). In an attempt to avoid association with any incriminating notes or documents, the suspect may endeavour to alter their handwriting in the comparison material.

Suspected of being involved in the kidnapping and killing of the baby son of the famous American aviator Charles Lindbergh,²⁴ an illegal German immigrant, Bruno Hauptmann, was arrested on the 19th September, 1934. Hauptmann was asked by the police to provide numerous samples of his handwriting and during the taking of these samples, the officers strongly believed that he had disguised his handwriting (Fisher, 1994, p.199). In his statement of the time, Special Agent Turrou wrote '[Hauptmann] knew we wanted to get a sample of his handwriting to check against the ransom notes and he managed to disguise his style' (cited in Gardner, 2004, p.158). When the samples of handwriting were compared with each other, the police officers noted that there were differences between the baselines of the writing, the size of the writing and the formation of individual letters and that these changes were sometimes made in the same paragraph (Fisher, p.199). In spite of this the numerous handwriting experts involved in the case believed that there were enough identifying characteristics in the sample writing to link the ransom notes to Hauptmann (Bergman and Berman, 2008, p.39).^{lxvii}

²⁴ See State v. Hauptmann, 115 N.J.L. 412, 180 A., 1935

1.3.3 Self-Disguise

When an individual disguises their signature or signs a fictitious signature, this is known as self-disguise. Two types of self-disguise are identified in the literature:

1.3.3.1 Auto forgery

Auto-forgery refers to genuine signatures that are deliberately disguised (Huber and Headrick, 1999, p.279; Levinson, 2002, p.50; Hayes, 2006, p.166). The signatures are authentic in that they are written by the named signatory, but the handwriting is deliberately altered with the intention of denying authorship at some later time (Harrison, 1955, p.749; Michel, 1978, p.25; Robertson, 1991, p.157; Hayes, 2006, p.160). Such contrived signatures are also known as ‘self-forgery’ (Ellen, 1997, p.34). Signatures may be disclaimed for personal benefit or to evade responsibility (Robertson, 1991, p.157). Auto-forgery is, according to Ellen (1997), a ‘common method of fraud’ (p.34). The most obvious features in a signature, such as its capital letters, will typically be affected, although it is necessary that the writer’s self-disguised signature should not be too dissimilar from their habitual signature so as to avoid rejection of the forgery (Ellen, p.34).

1.3.3.2 Spurious Signature

Another form of disguise in handwriting is the spurious or fictitious signature. A spurious signature is one that is not written in the name of the actual signatory and no attempt has been made by them to copy or simulate the signature of another person (Bradford and Bradford, 1992, p148). Typically, a person will resort to this type of disguise for two

reasons: when the authentic signatory's name and/or signature are unknown and when the signature of a fictitious person is required for a forged document that will benefit the person who produces it (Robertson, 1991, p.156; Harrison, 1962, p.753).

1.3.4 Fraud

To prevent self-incrimination, a person may disguise their handwriting whilst fraudulently manipulating financial data or altering legal or other documents for financial gain or other personal benefit (Webb, 1978, p.149; Koppenhaver, 2002, p.154). The wrongful addition, deletion or alteration of numerals will commonly be found in accounting records, invoices, purchase orders, shipping manifests, margin notations, legal contracts or agreements, cheques and other such documents (Keown, 1994, p.674; Koppenhaver, 2002, p.154).

1.3.5 Graffiti

In *The New Oxford Dictionary* (2001), 'graffiti' is defined as any writing^{lxviii} 'scribbled, scratched or sprayed illicitly on a wall or other surface in a public place' (p.796). Very often written graffiti will be created in a disguised hand. Robertson (1991) emphasises the antisocial nature of graffiti and writes that it 'has become a public eyesore, stirring disgust and causing considerable expense to cities, businesses, organizations, and individuals in cleaning up the unsightly scrawlings' (p.239). But graffiti is often more than just a minor nuisance; Koppenhaver (2002) comments that employees can be negatively affected by graffiti in the workplace which can result in a precipitous decline in morale (p.24). For Americans, graffiti increasingly became a symbol of what was perceived, both publicly and

politically, as the growing incivility and instability of the city of New York (Vitale, 2008, p.92). In response to this, and fearing that ‘unaddressed disorder is a sign that no one cares and invites both further disorder and more serious crime’,^{lxi} the New York Police Department elevated graffiti from being merely a ‘minor form of vandalism and youthful mischief into a significant crime’ (Vitale, p.92). Graffiti can be a considerable problem and it is important, Robertson (1991) believes, that all types of graffiti, whether written with lipstick on a bathroom mirror, scratched onto a painted surface with a sharp instrument, or even scrawled on the abdomen of a murder victim (Totty, 1981, p.349), should necessarily be treated and examined as possibly disguised anonymous writing (Robertson, p.24).

1.4 Methods of Disguise

Two persistent threads of enquiry and commentary in the literature focus on what are the methods most commonly used by those attempting to effect a disguise, and what are the elements in a handwriting most frequently targeted for alteration. Much of this information is based on anecdotal and experientially derived knowledge, but is, for all that, Wendt (2000) suggests, ‘significant in its detail and insights [and..] provides an initiative for empirical testing and analysis’ (p.20).^{lxx}

Disguise methods, Harris (1953) suggests, ‘vary with the ability and imagination of the writer’ (p.685); but despite the ‘infinite number of ways’ a person could disguise their handwriting (Alford, 1970, p.478),^{lxxi} results from the few empirical studies that there have been indicate that only a limited range of disguise techniques will be employed, and that in fact, ‘originality in disguise is rare’ (Harrison, 1962, p.757). In any one study, the number

of disguise techniques used by the participants varied between five (Kropinak, 1965) and twenty (Herkt, 1986).

Very few studies have focussed exclusively on the disguise of signatures, and work carried out by Herkt was an attempt to redress this balance by providing a controlled number of request writings of disguised and forged signatures to remedy the ‘void of controlled survey material’ (p.258).^{lxxii} Keckler (1997), on the other hand, specifically examined the extended writing samples of convicted criminals and reported sixteen commonly used modes of disguise,^{lxxiii} a finding which was, by and large, consistent with the twenty listed by Herkt (1986). Keckler considered that the handwriting of criminals would yield a more accurate representation of the methods used to disguise handwriting than would be the case if the writing samples had derived from randomly selected volunteer groups (p.154) , since the criminal’s motivation to preserve liberty and, in most cases, to acquire some material gain will always provide an incentive that is far greater than the motivation of those who are simply taking part in an experimental trial.

Based on his ‘previous examination experiences,’ Alford (1970) identified fifteen techniques of disguise as being those which were most likely to be used by writers (p.478) and compared these against one hundred and thirty-five disguised writing samples. In a similar approach, Wendt (2000) employed seventeen categories of disguise for comparison against his control group in a study which endeavoured, in part, to determine or reproduce the most popular methods of signature disguise (p.21).

The research performed by Leung et al. (1988) identified thirty-one methods of disguise used in Chinese handwriting, of which nearly half (fifteen) were found in English disguised handwriting (p.149). This work was primarily an examination of Chinese disguised handwriting, but the researchers ultimately concluded that despite clear (and considerable) structural differences between English and Chinese writing, the psychology of disguise was essentially the same for both language systems, if not for all language systems (p.149), and that the techniques for disguising both Chinese and English handwriting were similar, 'being simple and lacking originality'. Furthermore, the characteristics most often changed in disguised Chinese handwriting were generally found to be the same as those in English writing (p.164).

In a non-laboratory investigation into the methods of disguised handwriting, Downey (1917) reported that there were nine popular methods of disguise used by her subjects. While Downey's interest in handwriting disguise lay primarily in connection with its relation to psycho-diagnosis, with its emphasis on the psycho-physical factors that underlie the behaviour of the would-be disguiser, her findings, nonetheless, remain relevant and applicable to the area of forensic handwriting identification. Nine major disguise techniques were also identified by Konstantinidis (1987) in his study of extended text, which was conducted to discover which characteristics were most frequently disguised, and which methods were most favoured between different age groups, social backgrounds and/or occupations. Harris (1953) also conducted a non-laboratory test, similar to that undertaken by Downey, to discover the major tactics of disguise and to determine to what extent these were effective. This study, carried out over seventeen years, established that the participants only resorted to seven specific methods of disguise, a number that was

confirmed by McKasson and Lesk (1973) in their study of anonymous handwriting samples (cited in Hooten, 1990, p.19).

Fewer methods were reported by Michel (1978) and Kropinak (1965). In looking at the 'special problem' of whether a questioned signature can be identified as authentic but disguised, Michel discovered six major disguise tactics that were employed separately or in combination (p.25), while Kropinak's two-part study, which was in part an examination of uncontrolled disguised handwriting, reported five principal methods.

The common feature of all these studies, whether their findings are experimentally or experientially derived, is that they vary widely in their assessment of what are the most common forms of disguise and what is the single most likely disguise method to which the would-be disguiser will resort. Harris (1953), Kropinak (1965), Alford (1970), McKasson and Lesk (1973) and Konstantinidis (1987) have all reported an alteration in slant as being the disguise technique most favoured by their subjects, whereas Downey (1917), Leung et al. (1988) and Keckler (1997) have observed that a change in writing size is more frequently adopted. To add further confusion, the results from three studies carried out by Herkt (1986), Hull (1991) and Wendt (2000) have indicated that an alteration to capital letters is the method most likely to be utilized by those who wish to alter the appearance of their writing. This finding is contradicted by Muehlberger (1990) in light of the fact that his review of nine case studies identified block printing as being the most common tactic (cited by Wendt, 2000, p.20); but even this finding is challenged by Michel (1978) who reports that 'nearly half' his subjects reverted to a copy-book style of writing as a way of disguising their signatures (p.26).

‘The history of scholarship,’ commented Hughes (1936), ‘is a record of disagreements,’ and it seems that this is especially true in the field of handwriting analysis. So how is it that respected and able handwriting experts, who presumably share common background beliefs, can differ so widely in their findings and in the projection of their findings? The answer may, in part, be due to the limited number of empirical studies that have been conducted in this area which has resulted in the lack of a credible evidence base from which to create a consensus among those in the handwriting community of what is and what is not true; but while there appears to be no agreement as to the single most common disguise, these studies do indicate that disguise techniques will typically be chosen from only a limited range. ‘It is,’ Harrison (1962) wrote, ‘by no means a simple task to write in other than a normal hand’ (p.753). To alter a natural habit such as writing, which is largely produced unconsciously, to the extent that it will not be recognized, is an undertaking of such complexity, both mentally and physically, that any scheme for masking it will tend to be kept relatively simple and will rarely be original or imaginative (Harrison, 1966, p.350; Alford, 1970, p.477; Leung et al. 1988, p164; Hayes, 2006, p.160; Koppenhaver, 2007, p.167).

Experimental evidence suggests that the superficial elements that comprise the general appearance of handwriting are those most likely to be targeted for disguise. The theoretical perspective that informs this opinion is that writers are generally under the erroneous belief that handwriting is identified by its pictorial appearance alone and that, consequently, only superficial changes need be made to the writing to alter it beyond recognition (Ames, 1901, p.93; Harrison, 1966, p.350; Alford, 1970, p.488; Michel, 1978, p.29; Hooten, 1990, p.20; Hayes, 2006, p.160). The features that are said to be subject to the greatest alteration are those which govern the appearance of handwriting, such as its slant, size, style, layout, the

care and speed with which the writing is made, the connecting strokes which link individual letters and words, and the design of the writing's upper-case and lower-case letters (Blackburn and Caddell, 1909, p.9; Harrison, 1962, p.754). Indeed, in the empirical studies, all these features have been found to have been modified during disguise.

In order to explore the claims made in the literature respecting the most frequently used tactics for disguising handwriting, and to identify the elements in a writing that are most commonly altered, the findings from the empirical literature have been consolidated, as follows.

1.4.1 Writing Slant Alteration

'One of the most obvious features of an individual's handwriting,' Jamieson (1983) maintains, 'is its slope or slant' (p.117), and any changes made to this element of handwriting will significantly alter its appearance. The slant of a handwriting is one of its most prominent characteristics, and is for many writers, Osborn (1946) notes, 'one of the most fixed of habits' (p.144). Being such a pronounced and singularly characteristic feature, it is unsurprising that slant should be a favourite target for disguise. Indeed, many commentators, including Halder-Sinn (1992), Slyter (1995), Nickell (1996) and Koppenhaver (2007), agree with Dines (1998) when he states that a marked alteration of the slope or slant of a writing 'is *the* favourite, and *most common* method, of disguise' (p.278, italics added). However, the empirical studies can come to no such general consensus. Nevertheless, the results from these studies strongly support the observation that in handwritten disguise, an alteration of slant is a very common occurrence.

Harris (1953), Kropinak (1965), Mckasson and Lesk (1973) and Konstantinidis (1987) have all reported a change of slant to be the most common means by which extended handwriting is disguised. A high percentage of Downey's subjects (67%) also altered this feature, but it was not the most frequently used method in the study. This was also true in the studies conducted by Alford (1970), Michel et al. (1978), Leung et al. (1988), Herkt (1986) and Keckler (1997), where approximately one third of their participants chose to make alterations to their habitual slant as a disguise method. Only Wendt (2000) reported that a lower proportion (9%) of those in his study chose slant as their preferred means of disguise.

1.4.1.1 Direction of Slant Preferred

The experimental studies provide some interesting observations with respect to the direction of slant preferred by disguisers. A slight tendency was observed by Regent (1979; 20%) and Kropinak (1965; 29%) for a change of slant to be altered to a more exaggerated forward or rightward slant than the subjects' habitual hand. A very small tendency, 6% or less in all cases, was also found for slant to be altered from a back hand or leftward slope to one that was vertical or to one that was rightward sloping (Alford, 1970; Konstantinidis, 1987; Jamieson, 1983; Keckler, 1997). However, by far the most common way for habitual slant to be altered was from a rightward to a leftward direction, which accords well with claims made in the experimental literature.

Blackburn and Caddell (1909) have stated that it is 'the first impulse of the anonymous writer to avoid the right slope' and that a change to an extreme back hand slope occurs frequently in disguised writing (p.49).^{lxxiv} Overall, the studies showed a very strong

tendency for subjects to alter their habitual movement of slant from forward to vertical, from vertical to left (backhand), or from right to left, thereby completely reversing their normal slant. Both Regent (1979) and Jamieson (1983) have specifically explored the effects that a change of slant can have upon handwriting and in both cases, similar results were obtained: of the one hundred participants in Regent's study, it was observed that 80% changed their forward slope to a vertical or more back hand slope, while Jamieson found that 76% of his surveyed population changed their slope from rightward to a leftward direction. Equally high percentages have been reported by Alford (1970), Downey (1917), Harris (1953), Keckler (1997), Konstantinidis (1987) and Kropinak (1965),^{lxxv} and although Wendt's findings can only properly be considered as preliminary, since only a small number of his subjects used a change of slant as a method for disguising their handwriting,^{lxxvi} it was still the case that every writer who altered their slant changed it from a forehand to a backhand slope.

1.4.2 Letter Form Alteration

1.4.2.1 Capital Letters

An examination of the empirical studies shows that an alteration of a text's capital letters will occur more commonly than an alteration to its lower-case letters. Keckler (1997) and Downey (1917) believe that this is because capitals are more conspicuous than lower-case letters and that since capitals are made with a higher degree of conscious awareness, alterations to their form are more easily achieved (Downey, p.372). Indeed, Alford (1970), Herkt (1986), Konstantinidis (1987), Hull (1991), Keckler (1997) and Wendt (2000) have all observed the alteration of capital letters to be a frequent method of disguise, while

Alford (1970), Herkt (1986), Hull (1991) and Wendt (2000) identify it as the most preferred method by the participants in their studies.

In a presentation given at the 43rd annual meeting of the American Academy of Forensic Sciences (1991), a study was reported which explored the relationship between disguised handwriting (of extended text) and the level of education received by the writer (Hull, 1991, cited by Huber and Headrick, 1999, p.283 and Wendt, 2000, p.20). Hull concluded that education influenced the types of disguise used by his subjects and the number of methods utilized. However, the disguise technique that was found to be most common across all educational groups was the alteration of the formation of capital letters. Herkt's examination of disguised signatures found that alterations to capital letters varied from slight additions or deletions of strokes to whole new letter forms. Keckler (1997), on the other hand, found that the majority (72%) of the participants in his study who disguised their capitals did so by changing the overall design of these letters.

'Experience shows,' Harrison (1962) has stated, 'that the change of capitals from cursive to block letter is a popular device, occurring in no less than about 10 per cent of disguised handwritings' (p.756); but there has been only one researcher who has provided any data on this point. Nevertheless, Keckler (1997) has found that there was, in fact, a slight tendency for capitals to be altered from cursive to printed (17%) more often than vice versa (11%).

1.4.2.2 Lower-case Letters

Although form alteration is thought to occur more commonly to capital letters, it is still recognized that changes will sometimes be made to the lower-case letters; but Hayes (2006) maintains that any such modifications will typically be made to only the first and/or last letter of a word since this, he believes, ‘will cause the most immediately noticeable effect’ on the overall pictorial appearance of the writing (p.165).

Nevertheless, some commentators have described other modifications that disguisers make to their lower-case letters to camouflage them. In the first part of a survey conducted by Herkt (1986), which endeavoured to gather a body of controlled data on the likely methods of producing disguised signatures (p.257), it was found that 38% of the target group created more complete lower-case letter formations than was found in the writers’ control writing. Furthermore, the loop of the lower-case ‘l’ seemed to be of some significance since 15% of the 27 people that altered their lower-case letters omitted this loop (p.260). Alford, whose study was the only one to encompass an examination of disguise in both signatures and extended text, reported that the lower-case letters that were most commonly changed in his surveyed population were the letters ‘r’, ‘e’, ‘s’, ‘k’ and ‘t’. He also states that the frequency of change to the lower-case letter ‘t’ increased when it appeared as the last letter of a word (p.486). Herkt has also noted that the lower-case letter ‘t’ is often targeted for alteration by means of lowering its position, lengthening its cross-bar, adding or omitting its cross-bar, and/or using the cross-bar as part of the terminal stroke (p.261).

1.4.2.3 Ornamented, Simplified and Grotesque Writing

In considering whether disguised letter form variation tended towards simplification or embellishment, Downey (1917) found that half of those who altered the form of their natural letters employed ‘superfluous ornamentation,’ while 37.5% simplified letter formation. She also found that 12.5% disguised their letter forms by writing them in a ‘fantastic’ or grotesque manner. Konstantinidis (1987) and Leung et al. (1988) have both described similar results to Downey. Leung et al. reported that 22% of their subjects abbreviated their written characters as a form of disguise, while 11% resorted to grotesque letter designs; similarly, Konstantinidis found that 12% of his subjects produced ‘artistic or distorted letter shapes.’ Harris (1953) has also reported that 8% of his subjects wrote in a grotesque manner, but he found that they did so whilst at the same time changing the slant of their writing (p.688).

Compared to the copybook style of writing typically taught in primary schools, grotesque letter forms are characterised by their unnaturally distorted shape and/or abnormal size; as such, they are not, Leung et al. suggest, a ‘satisfactory’ means of disguise as they inevitably arouse suspicion in spite of the fact that the disguised version is vastly different from the normal hand’ (p.158).

Significantly, Alford (1970) has noted a correlation between the size of a disguised writing and the degree of embellishment used in the formation of letters: the larger the disguised writing, the more ornate or ‘fanciful’ it became. On the other hand, when the writing was made smaller, it became less embellished (p.480).

1.4.3 Letter Size Alteration

It is generally agreed in the anecdotal literature that a modification to the overall size of letters will be a common method of disguise since it is an element of natural handwriting that is relatively easy to manipulate and any change to this feature will cause a significant alteration to the overall appearance of the writing (Downey, 1917, p.374; Dines, 1998, p.279). However, there is little consensus as to the nature of change, whether, for instance, the writing will tend to increase in size or whether a decrease will be more common. ‘Most often,’ Dines argues, ‘the letters are made smaller’ (p.279); but others disagree. Harrison (1966) and Hayes (2006) assert that when the size of a disguised handwriting is compared to that which is normal for the writer, the writing will invariably be found to have increased in its overall size (Harrison, p.363; Hayes, p.164).

A number of empirical studies agree that an alteration to letter size is a commonly employed disguise (Downey, 1917; Kropinak, 1965; Alford, 1970; Mckasson and Lesk, 1973; Herkt, 1986; Leung et al., 1988; Keckler, 1997; Wendt, 2000). A general tendency has been observed for writers of disguised text to increase the size of their habitual hand, a fact that conflicts with the assertion made by Hamilton (1980) that a forger will tend to make his writing smaller ‘because of a psychological desire to conceal his fraud’ (pp.264-265). Nevertheless, Leung et al. (1988) have reported that 62% of the specimens of disguised writing they examined contained characters that increased in size, while only 10% became smaller. Kropinak (1965) and Wendt (2000) have also observed this phenomenon and notably their studies have produced closely corresponding results. Indeed, of those subjects who deliberately altered the size of their writing in Kropinak’s

study, 80% were found to have increased the size, while Wendt reported this figure to be 76%. Similarly, Kropinak found that 20% of his participants decreased the size of their writing, whereas 24% did so in the study conducted by Wendt. In addition, Alford (1970) has found that an increase in the overall height of letters occurred more frequently (65%) during disguise than a decrease in height (35%).

There are, however, two studies which found evidence to contradict these findings; indeed, the results obtained by Downey (1917) entirely overturn those found by Alford (1970): of the 71% of Downey's subjects who utilized a change of size to disguise their handwriting, 65% decreased the size of their writing while 35% increased it. Similarly, the findings made by Herkt (1986) reverse those made by Kropinak (1965): Herkt observed that of those who altered the size of their writing, 82% reduced the size whilst 18% increased it.

1.4.4 Initial and Terminal Stroke Modification

The visual complexion of handwriting can be significantly affected by the absence or presence of approach strokes (Alford, 1970, p.483). A high percentage (65%) of the subjects in Herkt's (1986) study of disguised signatures altered the initial lead-in or approach stroke of their signature or the terminal or end stroke as a method for disguising their writing. Of these, the majority, 72%, altered the appearance of the terminal stroke and 28% either added or deleted the initial stroke (p.259). Wendt (2000) found that a smaller percentage of subjects (13%) had made alterations to these strokes, but in all cases only the terminal strokes were affected.

In Alford's (1970) controlled study of disguised extended handwriting, he observed that a 'determined effort' had been made by 37% of his subjects to modify the approach strokes in their writing by adding or deleting them, while 28% 'changed the finishing strokes to some extent' (p.483). In particular, he found that alterations to the approach strokes was 'in almost all cases' confined to the letters 't', 'i', 'b' and 'h' (p.483), while changes to the terminal strokes were 'almost inevitably restricted' to the lowercase 's' (p.483).

While Alford found that the initial strokes were always altered by deletion (54%) or addition (46%), he also observed that the terminal strokes might be added, extended or embellished (53%) or would be diminished or omitted entirely (47%, p.483). Leung et al. have also reported that strokes were lengthened or shortened by 31% of their subjects and that this 'simple method of disguise is usually associated with the terminal strokes' (p.156). Leung et al. (1988) have also revealed that there was a greater tendency for these strokes to be lengthened (22%) than shortened (9%, p.154), a finding that accords with that made by Alford.

The percentage of subjects who made alterations to the initial and terminal strokes in Keckler's (1997) study was found to be much smaller; alterations to the initial strokes were made by only 5% of the writers and of these, the majority (61%) added strokes while 39% deleted them. Only 1% of the writers were observed to have altered their terminal strokes which they accomplished by deleting them (p.156).

Keckler and Alford are unanimous in their conclusion that in the case of extended writing, an alteration to the approach or terminal strokes is unlikely to be an effective disguise as it

will be difficult for the writer to maintain it consistently (Alford, p.483; Keckler, p.156).^{lxxvii} Herkt does not speculate as to why the initial and terminal strokes appear to be a popular method of signature disguise in his study, but it may be conjectured that since the amount of writing in a signature is relatively small compared with that of extended text, the significance of these strokes in terms of its pictorial appearance becomes much greater.

1.4.5 Connecting Stroke Alteration

Alteration to the connecting strokes was identified as a disguise tactic by only one study. Nevertheless, Downey (1917) found that such changes were frequently made by a large proportion of her participants (71%). Furthermore, she discovered that it was more common for the connecting strokes to be changed from an angular to a rounded connection than vice versa (p.373).

1.4.6 Angular Stroke Modification

The angularity of written strokes is a component of handwriting that if altered can profoundly affect the pictorial aspect (Alford, 1970, p.481) and yet it would appear, from the empirical studies at least, that this is a form of disguise that is rarely encountered.

In his statistical analysis of the methods and elements of disguised handwriting, Alford (1970) found that nearly a third of his subjects deliberately altered angularity. Lesser frequencies were found by Herkt (1986) in his examination of disguised signatures and by

Kropinak (1965) in his study of the effectiveness of disguised handwriting. Only 6% of Herkt's subjects and just 2% in Kropinak's study altered the angularity of their writing.

From Alford's results it is possible to discern a clear trend with regard to whether writing will become more rounded or more angular in disguise. Of the subjects that deliberately modified angularity, 70% produced a more rounded hand and 30% produced more angular writing (p.482). Conversely, Herkt and Kropinak both found that angular writing was more commonly used as a method of disguise. In addition, Herkt also observed that all those who altered angularity did so by increasing angularity at the apex of strokes (p.261).

1.4.7 Modification of Upper and Lower Extensions

Strokes that extend above the baseline of writing (ascenders) or descend below the baseline (descenders), be they looped or plain, and which form a part of some of the lower-case letters such as 'b', 'f', 'j', 'p', 'y' and the capital letter 'Q', are visually prominent, making them 'particularly susceptible to careful attention by the writer intent on deception' (Alford, 1970, p.483). Approximately 50% of Alford's subjects 'endeavored [sic] to reject their normal method of forming the upper and lower loops and to substitute alternate forms' (p.483). It was found that writers who habitually wrote with looped extensions would either omit the loops or change their size or shape (p.484).

Writers will also tend to alter only the upper *or* the lower extensions during disguise, and 'relatively few' individuals will attempt to change both (Alford, p.485). Only nine of the subjects (38%) in the study conducted by Downey (1917) attempted to alter the relative

length of upper or lower extensions, and she concludes that to increase the relative length of an upstroke is a task that is ‘particularly difficult’ for a writer to achieve since an increase in the relative length of a down stroke was found to occur twice as frequently as a decrease (Downey, p.373).

Similarly, Alford recorded ‘twice as many instances of lower loop alterations [...] than of those formed above the baseline of writing’ (p.484), and he concluded that the lower extensions of letters appear to be a more conspicuous feature of writing to the average person. This observation was also confirmed by Keckler (1997) who found that of those subjects in his study who deliberately modified these strokes, 54% of them changed only the lower strokes.

Just over a third of the subjects in Herkt’s (1986) study of disguised signatures (37%) altered their upper or lower projections, but in contrast with the results found by Alford, Keckler and Downey, Herkt reported that the great majority of these (70%) changed the upper projections while fewer subjects (37%) altered the strokes that descended below the baseline. However, as Herkt himself remarks, the alteration of the lower projections as a method of disguise assumes far greater significance ‘when it is considered that only sixteen of the subjects had lower projections in their names’ (p.260).

1.4.8 Handprinting

Handprinting may be described as the use of various types of non-cursive or disconnected lettering systems (Hayes, 2006, p.54). In 1929 A.S. Osborn stated in his landmark text

Questioned Documents that the use of handprinting instead of cursive writing was one of the five favourite methods for an individual to disguise their handwriting (p.407) and Robertson (1991) agrees (p.244). However, there appears to be no unanimity in the literature as to the unequivocal definition of the term *handprinting*. Some writers use different terms to describe handprinting, including *pen lettering*, *hand lettering*, *printing*, or *printed forms*, but with little or no further explanation (Harris 1953, p.686; Slyter 1995, p.57). Others supply more detail and include sub-categories of handprinting (Conway 1955, p.606; Hayes 2006, p.54). There are some points of agreement, but generally categories differ and the distinctions between them are blurred.^{lxxviii} However, from the literature, it is possible to identify the following categories of handprinting:

- **Block Lettering or Printing:** The exclusive use of non-cursive, upper-case letters.
- **Lower-case Printing:** Consisting entirely of disconnected, lower-case letters.
- **Manuscript:** Disconnected writing which combines upper and lower-case letters.
- **Printscript:** A combination of Manuscript printing and cursive writing. The majority of letters are printed, but some letters are joined with connecting strokes (Hayes, 2006, p.54).
- **Copy Book Style:** This resembles the slower, rounded, disconnected script that is taught to children before they learn the speedier cursive script.

Notwithstanding these sub-categories, it would seem from a review of the empirical literature that when handprinting is used as a form of disguise, the method that is almost exclusively chosen is block lettering, with copy book printing a popular second choice. The

use of capital or block letters to replace day-to-day cursive writing as a means of disguise is, Mendelsohn (1976) comments wryly, ‘an especially frequent dodge’ (p.79). Indeed in *Suspect Documents* (Harrison, 1966), which has long been regarded as one of the principal texts on the subject of document examination in the UK, Harrison states that a quarter of those who wish to disguise their writing choose to do so by writing in block capitals (p.360). Harrison attributes the popularity of this method to the writers’ ‘inability effectively to disguise the connected cursive style of handwriting’ and to ‘the general but quite erroneous impression [...] that no effective comparison can be made between different specimens of block lettering to determine whether or not they are of common authorship’ (p.360). Certainly, block lettering was the preferred method of writing by the recent and infamous ‘Amerithrax’ writer.^{lxxix} In what has been called ‘the worst biological attack [...] in U.S. history’ (FBI, 2010),^{lxxx} several anonymous letters containing anthrax were sent through the U.S. mail to a number of high profile American individuals shortly after the terrorist attacks of September 11th, 2001.^{lxxxii}

That block lettering is a popular disguise was confirmed by a review of nine case studies conducted by Muehlberger (1990), in which he concluded that this form of printing was the one most frequently used (cited by Wendt, 2000, p.20). This result concurs well with the work of Harris (1953). In the non-laboratory test that he conducted amongst his students to discover their preferred methods of disguise, he identified block lettering to be the third most popular method employed (p.688). Keckler (1997) also found this to be one of the predominant modes of handwriting disguise in his examination of the handwriting samples of four hundred criminals (p.157). Thirty-four per cent of Keckler’s subjects were found to have ‘changed from all cursive writing to all printing’ (p.156).^{lxxxii} Keckler concluded that this mode of disguise is used more frequently by ‘felons’ than by volunteer subjects used in past studies (p.156).^{lxxxiii}

A somewhat smaller percentage of subjects (4%) chose to use block printing as a method to 'camouflage' the text portions of writing in the study performed by Alford (1970). His findings confirmed an initial expectation that none of the subjects would use block lettering as an alternative form of writing signatures (p.480). This may not seem surprising, since genuine signatures printed in block capitals are generally not encountered; however, at variance with Alford's results were those generated by a survey that focussed solely on signature disguise which showed that printed letter forms were, in fact, utilized by 10% of the subjects as a method of disguising their signatures (Herkt, 1986). This proportion exceeded even that found by Alford for the disguising of extended text (p.261).^{lxxxiv} These findings accord with the claim that '[w]hen contriving a disguise, some writers will switch from their usual cursive signature to a printed form' (Slyter, 1995, p.57).

In four empirical studies it was observed that some subjects resorted to a slow, rounded style to disguise their writing which closely resembled the copy book style that is generally taught in primary schools (Kropinak, 1965; McKasson and Lesk, 1973; Michel, 1978; Wendt, 2000). Nearly half the subjects in Michel's study used this method of disguise to alter their signatures (p.26), while McKasson and Lesk (1973) found it to be the fifth most common disguise method (cited in Hooten, 1990, p.19).

Michel (1978) has observed that the disguise was sometimes only applied to single letters and occasionally to the 'entire script' (p.26). Fewer subjects (12%) employed this method of disguise in the signature study conducted by Wendt (2000) and in the examination of disguised handwriting carried out by Kropinak (1965). All three researchers are in agreement, however, that the adoption of such a disguise method can prove problematic for the handwriting examiner; indeed, it was not possible for Kropinak to identify the three

writers who used this method of disguise in his study because ‘each writer took pains to write slowly and plainly without any unnecessary flourish [which is] typical of copy-book’ (p.6). He implies that such plain, slow writing diminishes the individuality of the writing, making it difficult, if not impossible, to identify the author without suitable standards of comparison. Wendt suggests that this is because the letters are drawn rather than naturally written (p.26). Despite the fact that Wendt and Kropinak found lower frequencies of use than that found by Michel, all three studies suggest that this is a disguise tactic that is likely to prove more successful than others.

1.4.9 Adoption of Careless or Unskilled Writing

It is a well-established principle in the field of forensic handwriting identification that it is not possible for a person to write in a hand more skilled than his or her normal handwriting (Hooten 1990, p.18; Harrison 1966, p.352); but it is also a fact that ‘a skilful hand can very easily pretend to write in an awkward or unskilled manner’ (Hooten, p.18). The anecdotal literature is in general agreement that a common method of disguise is ‘simply to write with a deliberate carelessness or sloppiness’ (Nickell, 1996, p.49). Robertson (1991), Alford and Dick (1978) agree that to adopt a skill in writing that is less than the writer actually possesses is, in fact, one of the ‘most common’ methods of disguise (Robertson, p.245; Alford and Dick, p.421). By writing carelessly or clumsily, the writer will introduce to the text features that are illegible or distorted in an attempt to create evidence of a ‘near-illiterate’ writer (Ellen, 1997, p.32). Feigning deliberate carelessness as a handwriting disguise is, Nickell suggests, often done in the belief that this will make identification of the author difficult or impossible to accomplish (p.49).

In his survey of the most likely methods of producing disguised signatures, Herkt (1986) found that the third most popular disguise amongst his subjects was to alter the degree of care that they gave to the production of their signatures. He also observed that of those subjects that altered the degree of care they used, the majority (67%) produced a more careful signature, while 33% produced a 'very careless, slapdash effort that was little more than a scribble' (p.260).

This finding was not, however, replicated by Wendt (2000) in his study of disguised signatures, or, indeed, by Konstantinidis (1987) who focussed on disguised extended text. In both studies, only small proportions of writers chose to alter the degree of care they used in their disguises: 6% and 15% respectively. Furthermore, the two researchers concluded that the adoption of a more careless manner of writing than that normally used by the subjects was a more popular choice of disguise than that of writing with care. The majority (57%) of Konstantinidis's subjects produced disguised writings that were 'rather untidy and difficult to read' (p.388), while all of Wendt's subjects were found to have 'scrawled all or part of the name' which reduced the legibility of the writing (p.26).

1.4.10 Artificial Tremor

Dines (1998) and Hayes (2006) have reported that a forger will sometimes introduce artificial tremor into their disguised writing in an attempt to give the impression that the writer is ill, elderly, illiterate, or under the influence of alcohol or drugs (Dines, p.140; Hayes, p.166). Hayes has also suggested that the use of tremor might sometimes be an attempt to 'distort the writing so that minor features are less apparent,' and in this way attempt to hide any irregularities that their disguise might otherwise highlight (p.166). He

comments that such a disguise is unlikely to be successful since it is doubtful that the writer will be able to maintain consistency: ‘Areas of smoothness where the person forgot to write in a tremulous manner point toward disguise and, if sufficient, may assist in identification’ (p.166).

There has been only one empirical study relating to disguise that has reported the use of tremor as a disguise technique. Leung et al. (1988) found that under experimental conditions, nearly 16% of their subjects resorted to artificial tremor as a means of disguise and described this method as one that was ‘fairly sophisticated’ (p.160). However, as Leung et al. do not provide any detailed information about this feature, it is difficult to be certain whether the tremor observed was, in fact, a disguise technique or whether it was in reality a by-product of the process of disguise.

1.4.11 Speed Alteration

Closely associated to the alteration of writing care is the alteration of speed. This ‘frequently utilized method’ (Koppenhaver, 2002, p.148) is a technique whereby a ‘slow, belaboured writing or a hastily scribbled one’ is produced as a way of disguising the author’s identifying characteristics (Nickell, 1996, p.49). Dines (1998) comments that ‘[i]ncreasing the speed of a writing can alter its appearance dramatically. [...] Deliberate carelessness introduces distortions in the writing, producing poor features and style. The writing usually becomes illegible [...]’ (p.280).

That an alteration to speed is a common method of disguise is reinforced by the empirical literature, but there is only a weak indication of whether it is more common for the writing to be increased or decreased in speed than that which is typical for the writer.

Keckler (1997) found that a '[c]hange in the speed of writing [...] was one of the more frequently used modes of disguise' in his study (p.156). Similarly, Stephen McKasson and Joseph Lesk (1973) determined that an alteration of speed was the second most common means of disguise in their examination of anonymous handwriting samples and that disguised structures were always written more slowly (cited in Hooten, 1990, p.19). This finding was reinforced by the studies conducted by Herkt (1986) and Wendt (2000), although opposing conclusions were made by Leung et al. (1988) and Keckler (1997) who determined that it was more common for an alteration in speed to be made faster and to produce exemplars that were 'scribbled' in appearance (Leung et al., p.153; Keckler, p.156). This lack of consensus is apt to cause more confusion than clarity, but when the studies are considered overall, the results do reveal a tendency, albeit a very slight one, for a change in the speed of writing to become slower than that which is habitual to the writer.

1.4.12 Arrangement Habits Altered

The overall appearance of a writing is affected to a large degree by the way in which the writer organizes or lays out their writing on a blank page, envelope, printed form, cheque, or other document and by the manner in which they make use of the amount of writing space available to them (Robertson, 1991, p.313). The arrangement of a writing, Koppenhaver (2007) maintains, 'is an individual preference' (p.105), and is a characteristic that will tend to become fixed. Hayes (2006) has commented that a person wishing to alter

the appearance of their writing will sometimes try to change the ‘usual way his or her writing normally appears on the page’ (p.165). The features which constitute the category of arrangement are said in the literature to include the alignment of the baseline (that is the placement of writing relative to an actual printed or imaginary horizontal line), the placement of the writing in relation to the left and right hand margins, the spacing between written lines,^{lxxxv} paragraph indentation, paragraph division, address alignment and signature alignment (Harris, 1953, p.688; Harrison, 1966, p.333; Alford, 1970, p.483; Hayes, 2006, p.165; Koppenhaver, 2007, p.19).

A review of the empirical literature reveals that alterations to arrangement habits are indeed sometimes employed as a disguise method, but the evidence that emerges with regard to the frequency of their use is somewhat contradictory. In their studies of extended disguised handwriting, both Downey (1917) and Kropinak (1965) found this to be a popular strategy among their subjects. The alignment of the baseline was altered by 67% of Downey’s subjects^{lxxxvi} and by 40% of those taking part in Kropinak’s study (Downey, p.373; Kropinak, p.5). A further 23% of Kropinak’s subjects altered the usual manner by which they normally set out a letter (p.5). In his study of signature disguise, Herkt (1986) observed that a somewhat smaller, but still significant, proportion of his subjects (17%)^{lxxxvii} altered the arrangement of their signatures by ‘monogramming or separating the initials’ (p.260). However, other studies have not supported such strong findings: Harris (1953), Keckler (1997), Wendt (2000) and Alford (1970) all report that only small proportions of their subjects resorted to this method of disguise.^{lxxxviii} Wendt, who like Herkt focussed solely on the study of disguised signatures, found that only 2% of his subjects altered the arrangement of their writing, and this they achieved by altering the baseline. Alford, on the other hand, discovered that none of his subjects altered the

arrangement patterns of their signatures, but a small proportion (2%) did choose to alter the arrangement of their extended text.

1.4.12.1 Lateral Spacing Habits Altered

Somewhat problematic are the findings relating to the way in which the would-be disguiser alters the horizontal expansion or compression between letters and words in an attempt to distort the general appearance of their writing. As will be discussed in section 2.2.3.5, a confusion exists in some studies as to whether observed changes in lateral spacing were the result of a conscious attempt to disguise, or whether they were the consequence of some other alteration to the writing (Konstantinidis, 1987, p.387). Nonetheless, Kropinak (1965), Konstantinidis (1987), Keckler (1997), Michel (1978) and Wendt (2000) have all reported that an alteration of lateral spacing habits was employed as a specific disguise tactic, albeit by only a few of their subjects. None of these studies, however, reveal a clear trend as to whether it will be more common for a writer to increase or decrease their lateral spacing during disguise.

1.4.13 Special Character Modification

There was some evidence in the empirical studies that the ‘special characters’ of a writing, such as its diacritics and its punctuation marks, would be especially targeted for disguise (Keckler, 1997, p.157). Keckler reports that just over 9% of his subjects ‘chose to make changes in such characters as i-dots, commas, ampersands, number signs and dollar signs’ (p.157). On the other hand, Konstantinidis (1987) found that punctuation marks were not

disguised in his study, but that the shape and/or the placement of the umlaut, i-dots and the diacritic ring above the letter ‘a’^{lxxxix} were deliberately altered by 21% of his subjects.

The i-dot, also referred to as the tittle, and the full-stop were also found to be of significance in the studies conducted by Alford (1970), Downey (1917) and Herkt (1986). Indeed, Alford writes that ‘[a]lthough it was not initially contemplated that the *i* dot or period be included in the study, the prevalence of change made regarding this feature as an element of disguise dictated otherwise’ (p.486). Downey comments that the i-dot ‘may be observed from three points of view; its localization, that is, the distance it is placed above the line and its position directly above or to the right or the left of the *i*; secondly, its form, [...] and, thirdly, the time of its making, immediately after the letter itself or after the word or line has been written’ (p.373). However, it was found that there were ‘no obvious changes’ in the localization of the i-dot in the disguises that Downey collected during her study, although there were ‘several deliberate attempts to vary the form’ (p.373) by means of substituting a conventional dot with a circle or v-shaped figure.

This finding was supported by Alford. Of the 15% of his subjects who deliberately altered the i-dot and/or full-stop, 80% substituted a conventional dot with a circle-like structure. The remaining 20% who habitually wrote a circle-like structure substituted it with a conventional dot (p.486). Only nine subjects (13%) were found to have added or omitted the dot over the lower-case letter ‘i’ in Herkt’s study of disguised signatures, but the ratio of disguise likelihood can be raised to a more significant 29% since only thirty-one subjects (43%) contained this letter in their signature (Herkt, p.261). Herkt also reports that 22% of the writers in his study disguised their writing by either omitting or adding full stops. He concludes that ‘[s]ome of these cases may have been the result of natural

variation, but most were so definite that they had to be considered a disguise method' (p.260).

Only Downey speculates as to why the form of the i-dot might be changed by those effecting a disguise and concludes that writers may be 'motivated by a knowledge [...] of the fact that the dot of an i is most characteristic' (pp.373-374). But while a change to this feature will affect the overall appearance of writing, it will not, Hayes points out, affect the structure of the writing as a whole (p.166).

1.4.14 Use of the Non-Dominant Hand

The results pertaining to the frequency of use of the 'awkward' or non-dominant hand as a means for disguising handwriting shows remarkable consistency across the empirical studies. Alford (1970), Leung et al. (1988) and Wendt (2000) have all reported that only 6% of their subjects wrote with the opposite hand to that which they normally used as way of camouflaging their writing. This figure was found to be even lower in the study conducted by Keckler (1997), who comments that 'arrested felons do not consider the awkward hand as a very viable mode of disguise' (p.156); it would seem that few others do either.

That low frequencies were found in the empirical studies are surprising considering some of the observations that are made in the anecdotal literature. 'The anonymous letter writer' Hooten (1990) writes, 'often [...] uses the unfamiliar hand' (p.20), and Dines (1998) and

Koppenhaver (2002) agree that opposite hand writing is a method of disguise that is frequently utilized (Dines, p.285; Koppenhaver, p.148).^{xc}

Alford attributes the low frequencies to the fact that most people just ‘do not consider themselves capable of writing with the unaccustomed hand’ and also because a script made in this way will never create a product that could ever ‘be considered artistically acceptable for the purpose for which it was intended’ (p.480); indeed, Hayes (2006) has observed that the pictorial quality of writing is ‘grossly’ changed when the non-dominant hand is used and becomes ‘clumsy’ and ‘awkward’ (p.165).

1.4.15 Mirror Writing

A disguise method that is even more rarely employed than use of the non-dominant hand is mirror writing. Huber and Headrick (1999) define mirror writing to be that which ‘runs in the opposite direction to the normal pattern’. In a Western script, therefore, the writing would begin at the right side of the page and move to the left, ‘with reversed order in spelling and turning of the letter images’ (p.405). If a mirror is then held to the writing, it will then be possible to read the reflection of the writing in the conventional manner from left to right.^{xci} Only one subject in one study employed backward or mirror-writing as a method for disguising their handwriting (Keckler, 1997, p.157). However, the method appears to have been successful in terms of preventing identification of the writer since Keckler comments that when comparing the writers’ habitual, non-disguised writing with the mirror-writing ‘it was difficult to identify both writings as having been written by a common author’ (p.157).

1.4.16 Pen Pressure Alteration

Downey (1917), Herkt (1986), Konstantinidis (1987) and Leung et al. (1988), have all reported pen pressure as a means by which their subjects disguised their handwriting. The frequency of use varies significantly between the studies, but a comparison of their results shows that there was a tendency for the subjects to increase pen pressure from that which was is habitual to them.^{xcii}

However, interesting as this finding is, it must be viewed with some degree of caution. In light of the comments made by all four researchers, it is unclear just how much reliance we can place on these findings, and whether the alteration of pressure is actually a ‘prime tactic of disguise’, or an inevitable ‘by-product from other methods’ (Leung et al., p.160; Herkt, 1986, p.261). Konstantinidis ultimately chose to regard increased pen pressure as an ‘intentional’ disguise attempt even though he remained unsure whether it ‘was a deliberate attempt to disguise or if it was related to the writer’s effort to produce a good result’ (p.389). In similar vein, Leung et al. (1998) commented that ‘an increase in pen pressure may have been the result of a psychological stress on the part of the writer who attempted to distort his/her handwriting, [while] a decrease of pen pressure may have been the consequence of an accelerated writing speed’ (p.160).

Both writers, it seems, are unsure whether to classify pen-pressure as a method, or as an identifying characteristic of disguise. Only Downey appears to be more certain of her results when she writes that, ‘[c]ertain changes in line-quality were [...] very evident in a large number of cases. In a majority of specimens this change is in the direction of a heavier line’ (p.372). But even here, Downey qualifies her words by adding that ‘the

degree to which pressure varied in the natural and the disguised hand cannot be told with any degree of accuracy from the written product' (p.372). Such ambiguity will be avoided in this study by requesting that volunteers describe exactly how they disguised their specimens.

1.4.17 Use of Different Writing Instruments

Osborn (1929) has named a change of pen as being one of the five most popular methods used by those wishing to alter the appearance of their handwriting. Mansfield (1943) and Hayes (2006) agree that the use of a different pen to the one usually used 'is a favourite idea' as it 'may give an entirely misleading general appearance to the writing as a whole' (Mansfield, p.26; Hayes, p.165). Differences in pressure, shading, line width and the 'strength' of individual strokes are said by Hayes to be the result of a simple pen change. Felt-tip writing, for example, can 'successfully mask the minor features of writing due to the thickness of the pen and the black trail of ink that it produces' (p.165). Fortunately, however, both Hayes and Mansfield agree that a change of pen won't entirely eradicate those important features in a handwriting that can help to identify its author (Hayes, p.165; Mansfield, p.26).

Despite anecdotal claims that a change of pen is a popular disguise strategy, there have been only two researchers who have identified pen change as a method of disguise that was employed by the participants of their studies; however, in both cases, the frequency of use was relatively high. Kropinak (1965) observed that 44% of his subjects changed writing instruments, with two people choosing to use a pencil (p.2), while Harris (1953) found an even higher percentage. 'Although students were limited to the classroom,' Harris writes,

‘nearly 50% were resourceful enough to use a different ink or writing instrument on the disguised cards’ (p.688).

1.4.18 Omissions

The deliberate omission of letters was observed as a method of disguise by both Michel (1978) and Wendt (2000). Significantly, both studies were an examination of disguised signatures. Wendt reports that the third most prevalent method of disguise (24%) among his subjects was to omit letters ‘as a means of creating a deceptive signature’ (p.22). Michel also observed the use of this method in his study, but he suggests that it is a form of disguise that is unlikely to be successful (p.28).

1.4.19 Numeral Alteration

Approximately 9% of the ‘arrestees’ that Keckler (1997) studied ‘made any concerted effort to disguise their numbers’ (p.157). This low frequency would seem to suggest that the deliberate disguise of numerals will be a rare occurrence in real case situations, which accords well with observations that have been made in the experiential literature (Conway, 1959, pp.70-71; Dines, 1998, p.134; Hayes, 2006, p.166).

Of some interest, then, are the findings reported by Alford (1970). In stark contrast to Keckler’s results, a large percentage (70%) of the disguised writing that Alford studied ‘contained at least some changed number forms’ (p.487). Alford concluded that not only are writers aware of the individuality of number forms, but they also ‘possess the facility to

effectively modify the figures they normally use' (p.487). The changes that were observed included the adoption of a printed style, such as are 'associated with printed matter', the addition of serifs^{xciii} to normally plain figures, and the inclusion of 'foreign' designs (p.487).

1.4.20 Writing System Substitution and Deliberate Misspelling

There are two studies that have identified the use of misspelled words as a disguise method (Keckler, 1997; Leung et al. 1988) and three that have recorded a change of writing system as a specific tactic employed by their respondents to disguise their handwriting (Harris 1953; Konstantinidis, 1997; Michel, 1998). However, the results pertaining to these methods have not been included in this present study. The method of substituting one writing system for another is largely specific to the languages of Norway, Sweden and Germany (Romaine, 2009, Konstantinidis, 1997; Michel, 1998) where more than one system is used to record their languages. It is true that Harris (1953), a former examiner of questioned documents in California, has observed that one writer in his study successfully disguised their writing by changing from a 'modern commercial system'^{xciv} of writing to 'an individualized form of Spencerian' (p.687); nevertheless, these scripts are considered here as writing styles rather than as diverse writing systems since they are methods of penmanship that alter the visual appearance of the letterforms that occur in the same writing system: in this case the English system of writing.^{xcv}

The deliberate misspelling of words is a tactic that Harrison (1964) believes is 'probably the most common device' used to disguise writing in anonymous letters (p.167). However, Nickell (1996) refers to the spelling in a text as a form of 'internal evidence' (p.42) which

should not be considered so much a factor of handwriting, but rather a part of the linguistic structure of a text. Misspelled words more accurately reflect the idiosyncratic and distinctive markers that can linguistically identify a writer. Rather than being viewed as a method of handwriting disguise, misspelled words should be seen as a device to disguise the writer's 'idiolect': the 'linguistic impressions' created by any given speaker or writer which can be used to identify them (Coulthard, 1995, p.233).

Indeed, Ellen (1997) has warned about giving too much emphasis to spelling errors in a questioned document: 'This rather obvious feature is often given great weight by the layman, but those who examine documents regularly find that certain mistakes are so common as to provide little significant evidence [..].' He continues that 'practitioners in forensic handwriting comparison do not regard themselves as experts in the frequency of occurrence of misspellings, and are therefore not inclined to comment on them' (p.22).

1.5 Combining Disguises

The disguise techniques that have been described are sometimes employed singly, or are used in combination to effect a disguise. Leung et al. (1988) have reported that between two and ten disguise methods were used in 75% of the writing samples they studied and that two specimens contained as many as eighteen. However, empirical evidence suggests that despite the many and various ways that disguises could be combined, writers tend to limit the number and combinations they use; indeed Leung et al. conjecture that the particularly large number of combined disguise methods found in their study was because 'the Chinese character is more complicated in structure than its Latinized English

counterpart, thus allowing Chinese writers more choice in modifying their handwriting' (p.164).

Data collected by Wendt (2000) reveals that out of an index of seventeen potential disguise methods, the respondents 'used as many as five forms of disguise and as few as one' to camouflage their signatures (p.24). The 'vast majority' of writers (88% of all respondents) combined between one and three disguises, with the average being two. Wendt acknowledges that his findings differ appreciably to those obtained by Hull (1991) who found that the average number of disguises adopted by his subjects was seven (p.26). However, Wendt's findings reinforce those made in the study conducted by Konstantinidis (1987). Here it was found that 78%^{xvii} of all the respondents 'combined two or more methods [...] of disguise' (p.386).

Wendt also observed that when two techniques were used to disguise a signature, a combination of altered capital letters and altered letter construction would tend to be used (p.27), whereas the most common way to combine disguises in Konstantinidis' study was to alter slant and individual letter shapes (p.386).

A relationship between the number of disguises implemented and the recognisability of the disguised signature was revealed in the study conducted by Wendt. He found that as the number of disguise methods increased, so identification of the signature became more difficult (p.27).

2 CHARACTERISTICS OF DISGUISE

2.1 Why Disguise Characteristics Occur

‘In disguising their hand,’ Blackburn and Caddell wrote, ‘a writer may believe that they have entirely altered the character of their writing, but in reality all they have done ‘is to put on a different suit of clothes; the same man is in them’ (1909, p.9). With adequate examples of a suspect’s writing, it will become ‘demonstrably clear’, Slyter suggests, that disguised writing is merely ‘a distorted version of the same writing habits’ (p.57). It is theorized that a lack of knowledge on the part of the writer of the way in which they create their letters, together with a lack of physical and/or mental agility can all impact negatively on writing that has been disguised, in terms of its appearance and consistency, and that this can alert the examiner to the possibility of disguise.

The associative evidence theory that underpins most, if not all, criminal investigations is that postulated by Edmond Locard (1920), which states that the criminal will always bring something to the crime scene and take something of the crime scene away with them. ‘The truth is,’ Locard observed, ‘that nothing can act with the intensity associated with the criminal action without leaving a multitude of marks on its passage’ (p.139).^{xcvii} Speaking as one of the first modern forensic scientists, Locard was primarily concerned with the collection of physical trace evidence such as hair or fibres, but he apparently appreciated the diverse nature of this evidence, commenting that it is composed ‘of extremely varied types’ (p.139). Accordingly, his principle can readily be applied to the forensic

examination of handwriting. Indeed, thirty years after Locard first expounded his theory, Kirkland (1952) would define document examination and the identification of the authorship of writing as 'physical evidence' in his seminal text, *Crime Investigation*, in which he developed forensic investigative processes predicated on Locard's principle (p.470).

English-speaking translators have simplified the exchange principle to the simple maxim 'every contact leaves a trace' (Walls, 1968, p.11; Pyrek, 2007, p.223), and this principle can help to explain the causes of disguise characteristics. The intense effort of altering natural writing will cause the writer not only to make unintended mistakes in the writing line, but also to impart unwittingly something of themselves, or, more specifically, something of their unique and distinguishing writing habits into their disguises. Such errors will introduce a degree of inconsistency to the disguised writing which may enable a positive identification of its author to be made, providing that a sufficient quantity of sample writing from the person suspected of the disguise is available for comparison.

The written word, Melcher (1920) comments, is the product of two distinct parts: 'the physical method of performing the act, and the pictorial forms resulting from such performance' (p.209). Faults can occur in disguised writing simply because the disguiser is ignorant of the physical processes by which they create their letters and this will cause them to include naturally formed elements intermittently and inadvertently into their assumed writing (Alford, 1970, p.477). Slyter (1995) believes that a disguiser will never, in fact, eradicate all their automatically formed writing features, but will instead redistribute or rearrange them unknowingly when effecting their disguise. 'At the elemental level' he observes, 'both writings include the same individualized habits. The writer has merely

taken his own individualized building blocks and tried to assemble them in a non-typical manner' (p.57). Moreover, the disguiser may be physically incapable of consciously abandoning all of their distinguishing features, or changing them sufficiently to match the rest of their assumed writing (Melcher, 1920, p.209; Alford, 1970, p.476). Regardless of whether or not the disguiser is aware of any physical or mental limitations they may have, however minor, these will necessarily interfere, to a greater or lesser extent, with the process of writing and restrict the degree of change that the writer is physically able to achieve, thus making it difficult for them to omit all the habitual peculiarities of their natural writing.

In addition to the 'physical method' highlighted by Melcher, there is another important component that is necessary for the act of writing and crucial for the successful execution of disguise: cognitive ability. The mental conflict that is said to occur in the minds of those attempting to disguise their handwriting will impede the apparently effortless flow of writing that is said to be characteristic of a natural hand and will cause intermittent lapses back into normally formed writing. The habit of writing is said to be so 'ingrained' (Alford, p.476; Koppenhaver, 2007, p.148) that for most writers it will be impossible to lay aside 'a lifelong habit of writing, with its numberless unconscious details', whilst simultaneously substituting new and equally complex styles of writing by means of newly acquired and wholly unnatural methods (Ames, 1901, p.93).

Those who can remember learning to write, or who have ever watched a small child grappling with the acquisition of handwriting, will appreciate the difficulty of the task involved. Proficiency in writing is only achieved when the conscious act becomes one of unconsciousness; by the time proficiency is reached, the writer will have acquired certain

habits which will be neurologically fixed in the brain and which will serve to influence the production, style and formation of their writing (Dawson, 1985, p.170). There is in the act of writing a greater involvement of the brain than for almost any other activity, Robertson (1991) asserts, since the process involves the use of numerous mental functions, including intention, vision, memory, verbal thought, implicit speech, reading, imagination, form and space perception, sequential organization, and voluntary movements, 'all of which incorporate multiple areas of both lobes of the brain' (p.190). In addition, the writing process involves a complex succession of interchanging impulses between the neural centres of the brain at the formation of each individual letter. At every directional change of the pen, to facilitate a turn or to create an angle, for example, a whole new series of impulses to act, regulate and cease action are initiated (pp.188-189). Consequently, any attempt by a writer to alter their natural style of handwriting will set up a conflict between their various habitual motor-impulses, as a process of continual readjustment and inhibition of their normal, natural writing takes place. The result of this tension, Alford (1970) suggests, is that most writers will be unable to avoid reproducing those unconscious and habitual elements that are unique to them (p.476). The mental image we have of our letter formations, connections and other elements of our writing remain so constant, Mendelsohn (1976) insists, that we will always betray some personal peculiarities when we disguise our writing, 'even if we write with a pencil in our teeth' (p.155).

Conway (1978) has indicated that errors in disguised writing are due to a failure on the part of the writer to exercise 'the requisite mental patience and manual care in the execution of [the] planned disguise' (p.609); but this presupposes that the writer is able, at will, to command complete mental and physical control over the writing act. It is true that the degree to which the individual will be successful at destroying the individuality of their

handwriting will depend, to a very considerable extent, upon whether they can sustain the immense amount of concentration that is required for the task (Dines, 1978, p.276), but even this ability, Hayes (2000) suggests, ‘may not be sufficient to prevent mistakes, particularly if there is more than one disguised communication’ (p.151). The more a person writes, Koppenhaver (2002) asserts, the more likely they are to involuntarily revert back to their habitual manner of writing (p.91).

Saudek (1928) believes that when an individual deliberately alters their writing they ‘will tend to write with especial care and concentration at the outset, but as concentration lapses, the speed of the writing will increase as the writer reverts to a more automatically produced, graphically mature writing with its concomitant identifying features’ (p.138). This is because when a person writes naturally, the main focus of their attention will be on the content of the writing rather than on its production (Hayes, 2006, p.162). However, the process of disguise requires the writer to focus on the twin tasks of production *and* content simultaneously, and they must have the ability to control and regulate these at the same time. This is said to be a process so difficult to achieve that the disguiser’s focus of attention will necessarily shift from the content of the writing to its production (Hayes, 2006, p.162). Because writing is such an automatic process, Osborn (1929) states, at some point during the making of a disguise, and ‘particularly if the writers become ‘excited and vehement’, their attention will revert to the content of the writing as they inadvertently forget ‘the effort to disguise’; but in so doing, their writing will ‘almost inevitably’ lapse back into their natural hand (p.407).^{xcviii}

The attempt to perform consciously more than one task at a time further complicates the already complex process of writing. Such an attempt, Klingberg (2000) suggests, will cause

a deterioration of performance since the human capacity for conscious information processing is limited and only restricted amounts of information can be retained in working memory (p.98). As multiple tasks 'compete for some limited resource' in the brain (Klingberg, p.98), the new disguise style and method of writing will revert to one that is more reflexive and more natural. This accords with Downey's research in which she observed that as a disguised script progressed, so the writer's attention moved to the content of the writing; this shift from conscious to involuntary control was evidenced by the appearance of characteristic details of the writer's normal hand (1917. p.375). This finding was later reaffirmed by Herkt (1986), who reported that in his study, 'many' of his subjects found the task of disguising their signatures so difficult that they involuntarily reverted back to their normal styles of handwriting (p.265).

There will be certain writing features, some authors suggest, that will simply be beyond the awareness of the disguiser (Brewster, 1939, p.114; Alford, 1970, p.476), or whose significance will remain entirely hidden from them. Osborn (1929) has noted that important characteristics are often not disguised because the 'average writer [...] does not know what a handwriting characteristic is' and fails to recognize the 'peculiar and significant characteristics in his own writing as compared with writing in general' (p.407). Indeed, Michel (1978) found that nearly half his subjects produced signatures that fell 'clearly into the acceptable range of their authentic signatures' (p.28). Jamieson (1983) has also reported that while his subjects changed the design features of their writing, structural elements, such as the direction of strokes and the manner in which the letters were executed, remained habitual to the writer (p.118). More specifically, Zimmerman (1995) has noted that even if a person uses their non-dominant or unaccustomed hand to disguise their handwriting, they will tend to form their writing in their usual manner in the

erroneous belief that the distorted appearance that results from this method of disguise will be sufficient for the disguise to succeed (p.288). Similarly, it has been observed that writers will ‘rarely’ disguise their block capital printing habits as they are under the mistaken supposition that handprinting is, itself, a method of disguise (Harrison, 1966, p.359; Hayes, 2006, p.163), even though ‘printing has as much potential for uniqueness as handwriting’ (Hayes, p.163).

The incomplete knowledge that a writer has of their natural writing is, Harris (1953) declares, ‘[o]ur greatest aid’ in detecting disguise and identifying its author since it weighs ‘the odds heavily against them ever being successful in disguising it’ (p.686).

2.2 Identifying the Characteristics

The physical proofs of disguise and the importance of identifying them cannot be underestimated, Harris contends, since they imply intent, deceit, and a lack of authority (p.689). Constant reference is made in the literature to the classic features, disclosers or indicators of disguise, but often writers provide only generalized discussions and fail to specify these in detail (Huber and Headrick, p.279; Melcher, 1920, p.214; Alford and Dick, 1978, p.422; Hilton, 1952, p.553; Hooten, 1990, p.19).

Few have attempted to categorise the elements of disguise in the literature; where efforts have been made to do so, there appears always to be some confusion between the involuntary indicia of disguise, the characteristics themselves, and the methods by which the disguises were made. Accordingly, Koppenhaver (2007) has included a change of

pictorial effect, the introduction of unusual letter forms, and the alteration of the size of writing, its slant and its capital letters in her brief assessment of the characteristics of disguise (p.171). Other authorities similarly commingle methods and characteristics in their general considerations regarding disguise (Hayes, 2006, pp.162-163; Dines, 1998, pp.277-280). Nonetheless, the experiential literature is in general agreement that just as the presence of hesitations, pen-lifts and careful re-touching in writing can indicate simulated forgery, so there are certain elements that can identify disguised writing as artificial (Harris, 1953, p.686) and that these can render disguised writing as ‘recognizable from the normal, natural writings of other persons and from the normal natural writing of its author’ (Huber and Headrick, 1999, p.284).

2.2.1 Inconsistency in Disguised Writing

The ‘red flag’ that should alert the handwriting examiner to the possibility of intentional disguise is, Koppenhaver and others agree, inconsistency in the writing itself (Harris, 1953, p.686; Conway, 1959, p.609; Harrison, 1966, p.350; Mendelsohn, 1976, p.77; Bradford and Bradford, 1992, p.289; Huber and Headrick, 1999, p.284; Morris, 2000, p.172; Koppenhaver, 2007, p.164). A normal, natural writing style has been described by Franck (1988) as having a ‘consistent slant, congruous forms, good rhythm, speed and legibility’ (p.278), and its production will tend to remain constant. This will create a marked degree of internal consistency in the writing which will be revealed in the overall continuity of its writing features (Harrison, 1966, p.350; Dines, 1998, p.275).

In contrast, this continuity will be lacking in disguised writing where frequent changes will be found in the slant of the writing, the formation of letters, the spacing of words and lines,

pressure gradation, letter size, legibility and writing quality, as the writer attempts to replace their distinctive writing features with an entirely new set of characteristics (Harris 1953, p.686). This is not to say that natural writing will never vary; on the contrary, variation will be present to a greater or lesser degree, but the differences will serve to make up a normal range of variation for that writer, which will become the ‘master pattern’ (Morris, 2000, p.172) to which the writer will subconsciously refer during the act of writing. Other dynamic variables such as the writing surface, the writing instrument available and/or the health of the writer may inadvertently alter certain elements of their writing, but modifications will tend to be constrained within the normal range for that writer (Morris, 2000, p.172; Melcher, 1920, p.209). For the disguiser, there is no master pattern to which he can refer (Morris, p.172), so irregularities and inconsistencies will be introduced into the writing which will evidence the ‘struggle between persistent, natural habits and the effort to suppress them’ (Hilton, 1982, p.169).

But where specifically should inconsistency be looked for? Anecdotal evidence and a limited number of empirical studies suggest that the following features of writing will particularly lack consistency when they undergo deliberate alteration:

2.2.1.1 Frequent Changes in Slant

‘Inconsistencies in the slant or slope of a writing,’ Morris (2000) states, ‘beyond that found in normal, natural writing, is an indication that the writing could be disguised’ (p.172). If successive examples of one letter are examined in a questioned document ‘those which are characteristic will exhibit a fairly uniform degree of slope if executed at the same time and under the same pathological and physiological conditions [...]’, whereas disguised forms

will ‘exhibit a wide variation in the slopes’ (Quirke, 1930, p.79). Yet sudden and marked changes to the angle of slant will not be confined to individual letters alone; some entire sections of the disguised writing will be found to slope more than others, and some sections will revert back to the writer’s normal angle of slant (Ellen, 1997, p.33). Indeed, in a non-experimental appraisal of ‘some thousands of specimens’ of disguised handwriting, Harrison (1966) observed that very few writers were able to maintain their disguised slant and that ‘[w]ith the majority of those tested, it was found that as soon as the attention flagged, the slope tended to revert to that which was normal for the writer, but was changed back to the revised slope as soon as the reversion had become sufficiently marked to be noticeable to the writer’ (p.353).

That changing one’s natural writing slope is a difficult task to achieve uniformly is borne out by two empirical studies carried out by Alford (1970) and Jamieson (1983). Alford has reported that ‘the introduction of a pronounced departure from the normal slope was, for the most part, neither consistent nor successful. Rarely was the writer able to maintain an unnatural slope uniformly’ (p.479). This finding was reaffirmed by Jamieson, whose study specifically addressed the effects that slope change has on handwriting. Jamieson reported that a change of slope was inconsistent in 61% of the cases he examined and, in accordance with Harrison’s observation, he found that deliberate changes to the writing slope would be relatively uniform at the outset but would vary between the writer’s natural writing slant and the assumed slope as the writing progressed (p.121).

These findings are, however, somewhat challenged by the conclusions of a more recent study which, like Jamieson’s research, explored slope change exclusively. Halder-Sinn and Wegener (1992) investigated the controllability of slant in simple and multiple strategies

for disguising handwriting and found that a deliberate and pronounced change in slant can, in fact, be consistent, providing that this is the only modification that is made to the handwriting; if other elements are disguised at the same time, and this can be as few as one or two other features, then the newly adopted slant will become more vertical (p.479). Halder-Sinn and Wegener comment that their ‘results confirm that, when the disguising task becomes more difficult, the voluntary control over the slant is reduced’ (p.906).

2.2.1.2 Frequent Changes in Character Size

It was discussed in section 1.4.3 that a deliberate change of writing size is a common method of disguise. However, Downey (1917) cautions that not all size changes should be attributed to direct volition (p.374). The increased attention and mental control that is required of the writer during the act of disguise will, she states, often cause an unintended decrease in the size of the disguised writing (p.374). Nevertheless, she has also found that an unintended increase in the size of disguised writing will occur ‘in disguises in which attention is concentrated upon variation in the form of individual letters’ (p.374). This is, she believes, because letters are written as independent units instead of constituent parts of whole words, and an enlargement of the writing will occur because of a ‘discontinuity of the motor impulse’ (p.374). Hayes also submits that ‘difficult letters’ will generally be made larger by the disguiser ‘to compensate for [their] lack of skill’ in altering their natural handwriting (p.163).

Disguised writing will, therefore, display ‘a much greater diversity’ in the size of its letter forms than the more constant sizing that tends to accompany naturally produced writing (Quirke, 1930, p.79). This fluctuation has also been observed by Harrison (1962): ‘On

occasion it can be seen how the writer, becoming suddenly aware that his deliberate change of [...] size is ‘slipping’, makes a sudden reversion to the disguised [...] size which was assumed at the outset’ (p.755). Size inconsistency, Huber and Headrick (1999) assert, should, then, be viewed as one of the main distinguishing features of disguised handwriting (p.284).

2.2.1.2.1 *Looped Structures*

Jamieson (1983) has also observed a clear correlation between a deliberate change of slant and an unintentional change in the size of looped formations. He noticed that when natural writing slopes were changed to a backhanded or reversed slope, looped structures increased in size when compared with the writer’s naturally written loops. Conversely, when the writer increased their natural slope, looped formations were found to decrease in size, or to remain unchanged from their normal writing (p.121).

2.2.1.3 Frequent Changes in Letter Form

It is to be expected, Quirke (1930) maintains, that newly substituted letter forms will far outnumber those which are natural and characteristic (p.79). But whereas any characteristic elements will ‘show a high degree of consistency in the formation of details,’ the larger disguised group will vary substantially and exhibit ‘a wide diversity of affectations in the features of details’ (p.79). The presence of inconsistent letter designs in a questioned document is suspicious, Harrison (1966) states, if there is no obvious explanation as to why these inconsistencies have occurred. There is, he suggests, no reason why one specific

letter form should be substituted for another unless it is for the sake of legibility or elegance (pp.354-355), or unless the new design falls within the range of the writer's natural pattern of variation. The modification of individual letter forms, Hayes (2006) comments, 'is the most difficult disguise to maintain' (p.165), but it does have the merit of immediately altering the overall pictorial appearance of the writing.

That it is a popular method of disguise is borne out by a number of empirical studies which have observed that capital letters in particular are often targeted for alteration by those wishing to camouflage their writing (Alford, 1970; Herkt, 1986; Konstantinidis, 1987; Hull, 1991; Keckler, 1997; Wendt, 2000), although few writers, it would appear, attempt to make any design changes to their lower-case letters (Alford, p.486; Keckler, p.156). Nonetheless, changes to letter forms, be they upper or lower-case, will tend to be inconsistent. '[I]t is far less simple than it might appear,' insists Harrison (1966), to carry out any substitution of letter designs consistently throughout a fairly long passage [...] as the attention is relaxed, the forms of the letters which are normal to the handwriting creep back unnoticed' (p.355). This observation is confirmed by statistics obtained by Alford in his survey of how handwriting is most frequently disguised. He found that when writers substituted alternative forms for their capital letters, 'in many instances the writers did not adhere to a changed letter form successfully, but rather frequently lapsed back to their normal style of that letter' (p.485). He also found that 'lower-case styles remained basically unaffected' by disguise, although the 'majority' of those writers who did attempt some change to these letters found it 'impossible' to adhere consistently to the newly assumed forms (p.486).

Frequent and abrupt changes in design features can occur simply because it is beyond the mental capacity of the writer to produce exact, or even near duplicates, of every newly disguised form. Mendelsohn (1976) has stated that ‘most people are quite incapable of remembering in detail just what letters they disguised and how’ (p.77), and this, commentators agree, will almost invariably cause inconsistencies to appear in the writing (Dines, 1998, p.279). In western systems of contemporary handwriting, all letters of the alphabet are constructed by combining a few specific structural elements, including loops, arches, troughs and short straight lines (Harrison, 1966, p.357). For this reason, several pairs or groups of letters will share similar designs and will be constructed alike. This fact is of fundamental importance to any question of disguise, Harrison believes, since ‘it implies that if the internal consistency of the handwriting is to be preserved, any appreciable alteration in the design of one letter must be accompanied by a corresponding change in the design of structurally related letters.’ This, he suggests, will severely restrict both the nature and extent of any disguise that is made to the letter designs ‘without its presence become patent’ (p.359).

2.2.1.4 Inconsistency in the Initial and Terminal Strokes

Since the initial and terminal strokes are a relatively conspicuous feature of handwriting and any alteration to them will impart an overall change to the general appearance of writing, it is to be expected that some attempt will be made by the disguiser to modify them. Certainly, a large proportion of Herkt’s subjects were found to have deliberately altered these strokes as a way of disguising their writing, as was seen in section 1.4.4, although other studies have found this to be a method of disguise that is far less commonly used (Keckler, 1997; Wendt, 2000). Nevertheless, it is generally the case that where

attention has been given to the initial and/or terminal strokes, any attempts to disguise them consistently have been unsuccessful.

This is particularly true of longer texts where strokes will often be found to revert back to that which is habitual to the writer (Hayes, 2006, p.166). Accordingly, terminal strokes are said to be somewhat more important to the penetration of disguise than initial strokes because '[p]eople are generally most conscious of the first part of letters, words and lines' when they write so that any individual characteristic features will tend to be found towards the end of these (Hayes, 1999, p.166). This claim is supported by Alford (1970) who has reported that of those participants who deliberately altered their initial strokes in his study, 72% did not similarly change their terminal strokes.

It would also seem that some initial strokes are more susceptible to change than others. As was mentioned in section 1.4.4, Alford has found that modifications to approach strokes were always limited to the lower-case letters 't', 'i', 'b' and 'h', although writers would only attempt to change the approach strokes of one of these letters during disguise; but Alford comments that this was never accomplished consistently since 'a person omitting the normal approach stroke of the letter *t* would continue to place approach strokes on the letters *i*, *b* and *h* in the disguised writing' (p.483).

2.2.1.5 Inconsistency in Upper and Lower Extensions

It has been suggested that because of their visual prominence, the ascender or descender strokes (those that rise up above the x-height or mid-zone of writing and those that descend below the baseline) will be particularly liable to modification (Alford, 1970, p.483). But

Alford's findings also indicate that when such changes are made they will not be maintained uniformly throughout the disguise; even if the disguiser recognizes the impact that these strokes can have on the pictorial appearance of a text and makes a concerted effort to alter them, he or she will tend to overlook those extenders that occur within a word and will alter only those that occur in the first and/or last letter of a word (p.484).

2.2.1.6 Irregular Baseline

Writers agree that baseline alignment will often be disrupted by the act of disguise (Hayes, 2006, p.114). It has been observed that when a vertical or back slant is adopted this can cause the writing line to ascend and the reverse to occur if a forward slope is assumed (Hayes, p.164). This claim is in part supported by empirical evidence. A study that specifically explored the impact of slant change on handwriting found that a deliberate alteration of slant caused the baseline of the writing to increase 'upwards to the right' in 67% of the disguised samples (Jamieson, 1983, p.121), although no clear trend emerged when the writer adopted a forward slope.

Changes in baseline alignment were also observed by Herkt (1986) in his study of signature disguise, although he lists his findings under the heading of disguise methods. Nevertheless, he cautions that it is quite possible that these changes occurred as a direct consequence of the disguise methods used by his participants, rather than from any deliberate intent on the part of the writer (p.261). Consequently, his findings are included here. Herkt reported that 4% of his subjects exhibited a baseline in their disguised samples that was much lower than that which they normally produced (p.261).

Kropinak (1965), on the other hand, has found that certain disguise methods cause deterioration in the uniformity of the baseline. He has observed that those writers who employed a cramped hand position to effect their disguise, that is to say that the writing instrument was held in a ‘peculiar or cramped manner’ (p.2), and who normally exhibited good word and line alignment, all ‘showed evidence of change in alignment to an inferior quality’ (p.6). It is assumed that the term ‘inferior quality’ refers to a baseline that has become irregular and inconsistent, but regrettably, Kropinak provides no definition to clarify this point.

2.2.2 Degenerated Line Quality

A general consensus exists in the literature that simulations will display poor line quality (Gupta, 1979, p.52; Nickell, 1996, p.61; Koppenhaver, 2007, p.169; Lafone, 2005, p112). Indeed, Brewster (1932) plainly asserts that this characteristic is the ‘fundamental difference’ that sets simulated forgery apart from writing that has been disguised since a deliberately altered handwriting will usually display ‘no trace whatever of any effort or labour’ (p.114). But this distinction is not fully maintained by others; whilst most authorities on the subject agree that the evenness of the line of writing will be adversely affected by the process of simulation, many contend that it will also be similarly affected by disguise. For Hayes (2006), line quality is ‘one of the primary elements to be evaluated in determining whether or not [...] a passage of writing has been disguised’ (p.79). Regent (1979) highlights the ‘fundamental axiom’ that disguised writing is not completely natural and that any such attempt must, of necessity, be ‘a contrived, forced effort [...]’ (p.216), and it is this ‘forced effort’ that will have implications for the quality of the written line.

A smoothly flowing ink line^{xcix} is necessarily dependent upon the fluency with which an individual can direct and control his pen; a regular speed and rhythm of execution will result in a good line quality which will be evidenced by a general steadiness in the line, graduated pressure and shading, smoothly rounded curves and an absence of breaks and patching (Lafone, 2005, p.13). Naturally written strokes will typically have what a court of law once described as a ‘dash and a swing’ about them: a continuity of motion ‘that evidences a quick and confident penman’ (Albinger’s Will, 30 Misc. Rep. 187, 63 N.Y. S.744).^c But ‘[r]hythm is fragile,’ states Robertson (1991), and ‘it can be disrupted if a writer attempts to change even a single feature of his or her writing’ (p.141).

The first casualty, then, of any disruption to the writing, be it caused by disguise or simulation, is apt to be a deterioration in the uniform rhythm and fluency that is generally associated with a natural hand (Dines, 1998, p.277; Koppenhaver, 2002, p.148; Hayes, 2006, p.114). Indeed, Kropinak (1965) has observed that when the participants of his study produced disguises made with the non-dominant hand, the ‘general aesthetic qualities’ of 90% of these writings deteriorated (p.4). This will be evidenced, Hayes (2006) suggests, by a ‘clumsy, awkward appearance’ (p.165). Once again, inconsistency seems key to the question of disguise: whereas simulated writing might display a line quality that is uniformly poor, that of disguised writing will tend to exhibit variations in skill. Where erratic writing precedes even, rhythmic writing, Koppenhaver (2007) suggests, then disguise is likely to be the underlying cause (p.163).

From the literature, it is possible to identify a number of faults that are said to occur in the ink line when the fluency and rhythm of writing decreases as a direct result of the artificial manner by which handwriting is disguised. All of these features have traditionally been

regarded as important to the determination of deviant writing but are frequently classified separately, a fact that has been acknowledged previously in a study of simulations (Lafone, 2005); this study concluded that the ‘degree of smoothness in the ink line’ is ‘necessarily dependent upon these characteristics’ (p.14); consequently, they have been treated as subsets of degenerated line quality here.

This revised classification has, then, been used for this current research, with two exceptions: the characteristic features of blunted stroke ends and pressure variation were categorized in the study of simulations under separate headings; but their presence in handwriting undoubtedly has a significant effect upon the appearance and quality of the written line. It is, therefore, felt that the classification of degenerated line quality should be further expanded to incorporate these interrelated components.

2.2.2.1 Speed and Pressure Variation

The chief determinant of the quality of the written line is said to be the speed at which it was written (Koppenhaver, 2007, p.17). Accordingly, a disguised script will often display contradictory signs of speed in its ink line (Saudek, 1928, p.141; Morris, 2000, p.172). Since disguised writing is often performed at varying speeds, this will be evidenced in the ink line by erratic and inconsistent pressure patterns. This appearance contrasts sharply with the naturally varying but consistent pressure patterns that generally accompany genuine handwriting and which results in a contrast of lighter, thinner strokes with ones that are darker and thicker. This happens as a natural hand/finger movement of contraction and release causes lighter pressure to be applied to the up-strokes as the pen is pushed away from the writer and heavier pressure to be applied to the down strokes as the pen is

pulled towards them (Koppenhaver, 2007, p.15, Robertson, 1991, p.124). But when a writer deliberately alters the design or style of a letter, this will generally be accomplished more slowly and with less contrasting pressure (Morris, p.172; Robertson, 1991, pp.140-141). Similarly, if slant is modified, this, too, can simultaneously result in a heavier pressure than that which is habitual to the writer (Dines, p.99).^{ci} Dines suggests that intensified pressure comes from a reduction in the speed of the forward movement of the pen, due to the writer's 'total and intense concentration on the writing movement' (p.276). This, Robertson (1991) adds, will be evidenced by broader line widths, uniformly darker lines - due to an increased concentration of ink, deeper indentations or grooves in the writing surface, together with a possible displacement of paper fibres (p.124).

The changes in pen pressure that are said to accompany disguised writing will not, by and large, be uniform throughout the text. Indeed, Kropinak (2007) has noted that 'erratic and inconsistent' pen pressure will generally be produced by disguises that are made with the unaccustomed hand. It is generally thought that as conscious control over the disguised writing relaxes, particularly during lengthier pieces of text, the writing will become progressively freer and faster as it reverts once more to the 'careless rapture of genuine writing' (Mendelsohn, 1976, p.140). As this occurs, so the writer's habitual pressure patterns will resurface.

Writing pressure has been described as 'one of the most individually typical features of handwriting' (Saudek, 1928, p.140). That it is an element that is difficult to modify is supported by the results of a study conducted by Konstantinidis (1987), which showed that no writer was able to alter their natural variations in pen pressure successfully (p.389).

2.2.2.2 Retouching and Overwriting

The terms retouching and overwriting are often used synonymously in the literature to refer to writing that has been patched or repaired to improve its overall appearance (Brewster, 1932; Hilton, 1982). Nonetheless, a distinction has been identified between the two terms: whereas retouching is an attempt to repair certain small areas of writing, overwriting is where there has been a complete retracing of letters or words (Lafone, 2005, p.24).

Anecdotal evidence suggests that genuine writing will often exhibit corrections and patching to the written line (Bradford and Bradford, 1992, p.152) and that, commonly, this will be done casually or carelessly to correct spelling mistakes or to improve legibility (Harrison, 1966, p.354). The ‘careful disguiser,’ on the other hand, will retouch and overwrite parts of the writing delicately to conceal identifying features, to add back in any omitted ornamentations that were assumed at the outset of the disguise, or to correct any errors in the writing line that he or she perceives is necessary for the maintenance of consistency, which is crucial for the overall integrity of the script (Harris, 1952, p.686; Ellen, 1997, p.33). If an error is spotted in the disguise, Harrison (1962) says, ‘few can resist the temptation to alter it by careful overwriting rather than by making a thorough job of the disguise by rewriting the whole page’ (p.756).

The presence of overwriting or retouching is, states Harris (1953), ‘strong evidence of the writer’s attempt to deceive’ (p.686), and there is some evidence to support these views. Three independent studies found that some subjects introduced retouching and unnecessary alterations into their disguised writing (Downey, 1917; Herkt, 1986; Leung et al., 1988). Leung et al. concluded that such alterations are evidence of the writer’s attempt to

‘maintain the disguise by altering those parts of the writing which were found to contain some of his/her normal writing habits’ (p.159). Leung et al. and Downey agree that in cases where it is suspected that a handwriting has been disguised ‘a thorough search’ should be made for unnecessary alterations since these ‘will indubitably reveal the fact that an attempt has been made to disguise the handwriting’ (Leung et al. p.159; Downey, p.379).

2.2.2.3 Hesitation

The characteristic of hesitation as it relates to disguise is not discussed in any great detail in the literature, but there is a general assumption among some writers that signs of hesitation will be found in writing that has been purposely modified (Hilton, 1982, p.169; Bradford and Bradford, 1992, p.152; Dines, 1998, p.277).

If a person is uncertain about the changes they are making to their writing, he or she may stop their pen and hesitate while giving thought to the direction that their next stroke should take; the writer may pause for only the briefest of moments but it will be long enough to leave a concentration of ink deposited at the place where the pen is halted. In simulations, this has been observed to cause the following errors: a) oscillations in the line which creates a jagged appearance to otherwise smooth strokes, b) indentation marks at the point at which the pen has been stopped and c) a firm, clear pen mark to the side of the written strokes where the writer apparently placed their pen so as not to obscure their view (Lafone, 2005, p.119).

In an attempt to obtain data on the most ‘likely [disguise] methods’ used, Herkt (1986) observed that 28% of his subjects ‘exhibited definite signs of hesitation’ (p.260). Herkt concedes that it is possible that ‘a very few’ of the subjects could have simulated hesitation as a means of disguise (p.260), but since ‘many’ of his subjects stated explicitly ‘that they found it difficult to effect a disguise without their writing becoming hesitant’ (p.260), he ultimately concludes that the category of hesitation was ‘an unavoidable by-product of the overall effort of the ‘disguises’’ (p.261).

Harris (1953) has commented that marks of hesitation are ‘caused by the writer deliberating in order to avoid his natural writing habits [...]’ (p.686). Nickell (1996) agrees, adding that such obvious pauses in the ink line provide evidence of conflict in the mind of the writer and reveal the very great difficulty of altering one’s writing (p.50).

2.2.2.4 Pen-Lift

In the theoretical literature, the concept of pen-lift as it relates to the issue of disguise is somewhat different from that of simulations where pen-lifts are considered unnatural when they occur within strokes that would normally be made in one continuous movement (Gupta, 1979, p.20). Instead, it appears that the personal idiosyncrasies of the writer with respect to when and where they lift their pen when forming letters and words are of most evidential value in questions of disguise.

It has been suggested that most writers will be unaware of their usual habits of lifting the pen when writing and that these oft repeated but entirely unconscious tendencies will be perpetuated in their disguised writing (Dines, 1998, p.277). Hayes (2006) refers to these

pen-lifts as *hiatuses* and suggests that they create distinctive gaps where ‘[m]ost writing systems allow for no gaps’ (p.42). Breaks occurring after capital letters and between syllables, he suggests, are often found in natural writing, and a break made before the lower-case letters *c, d, g or o* ‘is quite common’; it is also not unusual for breaks to occur before the small letters *h, m, n, t* and after the letter *q* (p.42). But apart from these exceptions, letters are customarily joined, and breaks that occur between other letters and/or words are likely to be idiosyncratic rather than applicable to all writers, and are, therefore, of strong evidential value. Of particular importance, Hayes asserts, is an examination of the distance between the pen lift and the placement of the pen back onto the paper, since ‘[m]ost writers adhere to a fixed distance when creating such breaks, even when attempting disguise’ (p.42).

Notwithstanding the anecdotal emphasis on individualistic patterns of pen-lift, what little empirical evidence there is suggests that the number of pen-lifts or breaks between letters will increase as a direct and involuntary consequence of the process of disguise. Saudek (1928) has found that when disguises are written slowly the ink lines will become ‘occasionally’ broken (p.141), while Herkt (1986) reports that 21%^{cii} of his subjects ‘introduced additional breaks between the letters’ when disguising their writing and concludes that it is ‘probable’ that these ‘faults’ were not the result of deliberate intent but from the unnatural effort of creating a disguise (pp.260-61).

2.2.2.5 Blunt ends

One of the characteristics that is said to distinguish natural free-flowing handwriting is the presence of finely tapered initial and terminal strokes, and hooked or dragged strokes

which are found at the end of disconnected letters (Bradford and Bradford, 1992, p.289). These are caused by swift, uninhibited pen movements where the pen is already in motion before it touches the paper to commence writing and keeps moving when it leaves the paper.

Bradford and Bradford (1992) and Hayes (2006) agree that such indicators of speed and fluency will often be lacking in disguised writing since its unnatural production will often cause the writing to reduce in speed and this will, in turn, cause strokes to become blunted or clubbed appearance (Bradford and Bradford, p.289; Hayes, p.119). However, there is as yet no empirical evidence with which to substantiate these claims.

2.2.2.6 Tremor

The presence of tremor in disguised writing is discussed only very briefly in the anecdotal literature and is often no more than a passing reference in a larger discussion of unnaturally executed handwriting (Dines, 1998, p.140; Hayes, 2006, p.119). However, Hayes (2006) and Bradford and Bradford (1992) have stated that '[d]isguised writing is usually carefully drawn' (Bradford, p.152) and as a result will be characterised, among other things, by tremor (Hayes, 2006, p.114). Dines also reports that tremor will be found in those disguises that have been made with the unaccustomed hand (p.281. See also section 2.2.4). Nevertheless, the characteristic of tremor has not been reported in any of the empirical studies that relate to disguise.

2.2.3 Inconspicuous Details Remain Undisguised

Researchers and commentators agree overwhelmingly that the inconspicuous elements of a writing will often remain undisguised and so will reveal important characteristic traits of the writer (Ainsworth, 1931, p.174; Harrison, 1966, p.350; Mendelsohn, 1976, p.79; Hilton, 1982, p.169; Huber and Headrick, 1999, p.281; Hayes, 2006, p.161). It is, observes Brewster, on ‘the outstanding features that the disguising writer concentrates his efforts, leaving untouched those hidden and unconscious attributes of which he is unaware’ (p.114), and it is to these ‘hidden attributes’ that we now turn.

2.2.3.1 Connectors

Osborn (1929) has stated unequivocally that ‘the degree of curvature and the slant of connecting strokes is one of the most significant variations in handwriting’ (p251), and yet authorities agree that the manner in which a writer connects their letters is a feature of writing that is apt to go unnoticed by the disguiser (Harrison, 1962, p.758; Dines, 1998, p.277; Hayes, 2006, p.168). This is supported by an empirical study conducted by Kropinak (1965) who observed that when handwriting was disguised by a change of either pen hold, slant, letter or writing hand, the subject would still continue to connect their letters in the manner that was normal for them in their natural handwriting (p.5).

Furthermore, the connecting strokes in a disguised script will frequently exhibit inconsistency in their appearance since the unnatural and intense concentration that is required during the process of disguise will cause these strokes to vary in slant and/or to display awkwardly made movements in their ink line (Hayes, 2006, p.162).

2.2.3.2 Cross-bars

Among the apparently inconspicuous features that the disguiser will tend to produce without much thought is the way in which the cross-bar of the lower-case or upper-case 'T' is formed. This is a feature, therefore, that should be particularly examined by the document examiner (Harrison, 1962, p.760). Consistent alterations to this minor detail 'are rarely found,' Harrison states, and the structural formation of this stroke will often remain characteristic to the disguiser (p.758).

Moreover, Mikels (1971) has observed that a characteristic of left-handed writing is the distinctive pattern of crossing the letter 't' from right to left which can be identified, he states, by observing 'the tapering effect on the left side of the cross-bar' (p.81). If the unaccustomed left hand is used to create a disguised handwriting, the resulting stroke 'will frequently be 'wavy' or slanted' (Mikels, p.81).

2.2.3.3 Arrangement

It was discussed in section 1.4.12 that the arrangement of text on a page is sometimes changed as a disguise strategy, but the findings from a number of empirical studies indicate that it will be more common for arrangement patterns to be overlooked by the disguiser.

Having explored the effectiveness of various methods of disguising handwriting, Kropinak (1965) reported that when hand printing was used, the majority of his participants 'continued to execute their disguises without any noticeable change in their writing arrangement or alignment' (p.3). Similarly, Harris (1953), Alford (1970), Keckler (1997)

and Wendt (2000) have found that an overwhelming majority of their subjects failed to alter their arrangement habits in any way.

These four studies all sought to determine which methods of disguise are those most commonly used, although the focus of interest differed for each study; whereas Alford studied both extended text and signatures, Keckler and Harris dealt exclusively with the disguise of extended text, while Wendt examined only signatures. Despite these differences, the studies display a remarkable level of consistency and strength with regard to their findings on the disguise of arrangement habits. Alford reported that none of his participants altered the habitual arrangement of their writing as a disguise method, while Keckler, Alford, Wendt and Harris found that nearly all their subjects had failed to do so (99.5%; 98%, 98% and 90% respectively).

Such overwhelmingly strong findings, Keckler and Alford agree, confirm 'the commonly held belief that such traits are rarely considered by the person attempting disguise' (Alford p.480; Keckler p.156). This conclusion accords well with anecdotal evidence. Harrison (1966) has stated that 'even when writing has been thoroughly disguised, its alignment relative to any lines ruled on the paper stays constant so that this alignment habit may be regarded as a relatively fixed characteristic of a handwriting' (Harrison, 1966, p.335).

The literature highlights those arrangement features that are most likely to remain undisguised:

2.2.3.3.1 *Baseline Alignment*

Harrison (1967) has noted that in the case of both disguised signatures and extended text, an examination of the writing relative to a pre-drawn baseline is 'all-important' (p.114). Notwithstanding the fact that Jamieson (1983), Herkt (1986) and Kropinak (1965) have found that certain disguise methods will cause specific changes to the uniformity of the baseline (see section 2.2.1.6), Harrison (1966) has observed that disguised writing will often conform completely to the writer's habitual method of arranging their writing in relation to the printed line when lined paper was used (p.372).

However, Dines (1998) asserts that in the case of handprinting, individual alignment traits will persist whether or not the writing is on lined or unlined paper. In particular, he says, the alignment of certain frequently used hand printed words such as 'and' or 'the' should be especially examined as they will for the most part conform to the writer's distinctive habits, even if attempts have been made to alter the baseline elsewhere (p.129).

2.2.3.3.2 *Envelope Arrangement*

'Experience has shown,' wrote Harrison (1954), 'that written matter on envelopes is rarely disguised as thoroughly as the contents of envelopes' (p.353), and other authorities agree (Hayes, 2006, p.165). It is said that the manner and style in which a person lays out their writing on an envelope is often highly distinctive and is a custom 'from which they seem incapable of

departing' (Harrison, 1964, p.168). For this reason, Keown (1994) urges that, '[a] prudent examiner will value the envelope in which an anonymous letter is sent as much as, or even more than, the letter itself' (p.691).

2.2.3.4 Special Characters

Anecdotal evidence suggests that punctuation marks, diacritics and abbreviations will be rarely modified by a person disguising their writing (Harrison, 1966, p.341; Hayes, 2006, p.47). Moreover, it is suggested that their design, size and placement in relation to the baseline and other characters or numerals can be highly idiosyncratic since there are 'few readily conceived alternatives' with which to substitute or alter these features (Huber and Headrick, 1999, p.281; Hayes, 2006, p.166; Koppenhaver, 2002, p.91). Harrison (1966) believes that the punctuation on an envelope is of particular evidential value since these will be 'rarely varied', even when concerted efforts are made to disguise the handwriting of the contents of the envelope (Harrison, 1966, p.341).

Relatively small marks such as full stops, commas and speech marks, and frequently used characters such as ampersands, monetary symbols and common abbreviations such as Mr., Mrs., Ms., or Dr. appear to be less visible to the disguiser than the letters and words which serve to make up the writing. Since these symbols and signs have little to do with the overall appearance of the writing, but everything to do with the conveyance of meaning and the ease and rapidity with which that meaning can be understood, it is theorized that few appreciate the individuality of these features or understand their evidential importance. Accordingly, punctuation marks, diacritics and abbreviations will often be overlooked and

so remain undisguised (Harrison, 1966, p.341; Alford and Bertocchi, 1974;^{ciii} Hayes, 2006, p.166).

Hayes (2006) emphasizes the importance of examining the method and placement of the tittle, or small dot of the lower-case letter 'i'. This feature, he states, can be highly characteristic as 'the writer is probably unaware of any individuality in making these small marks' (p159). This is a proposition that is supported by Harrison (1962) who states that consistent alterations to the nature and position of the 'i' dot are 'rarely found' (p.758).

Findings from a small number of empirical studies suggest that deliberate modifications will sometimes be made to certain special characters (Downey 1917; Alford, 1970; Herkt, 1986; Konstantinidis 1987; Keckler 1997);^{civ} but the frequency of occurrence of such changes in these studies is consistently low, and the vast majority of those who produced disguised samples for these studies failed to alter either the design or the placement of their special characters. Indeed, 91% of Keckler's surveyed population made no attempt to disguise their punctuation marks, ampersands and dollar signs. Similarly, Herkt reported that although a small proportion of his subjects altered the more eye-catching elements of full-stops or 'i'-dots as a method of disguise, the greater majority did not. Furthermore, no subjects were found to have altered their punctuation marks in either of the studies conducted by Herkt or Konstantinidis. Keckler and Alford conclude that the low frequencies that these studies have generated confirm 'the commonly held belief that such traits are rarely considered by the person attempting disguise' (Alford, p.480; Keckler, p.156).

2.2.3.5 Spacing

There have been only a few empirical studies that have specifically considered the question of spacing as it relates to disguised handwriting, and these have concentrated on the lateral expansion or compression of words and letters. However, the conclusions drawn from some of these studies reflect the confusion previously noted in section 1.4.12.1 as to whether an observable change in spacing is due to deliberate intention or is the accidental consequence of a specific method of disguise. For example, it was noted that Konstantinidis had observed changes to lateral spacing habits in his study of disguised handwriting and chose to classify these under the category of *methods of disguise*. But he remained unclear as to the actual cause of these changes and questioned whether they were, in fact, the product of deliberate alteration:

‘It is possible-even probable-that the altered use of space in some cases was related to a change in slant [...] this problem could not be entirely solved because the writers involved were not asked about it [...]’ (p.387).

Similarly, Jamieson (1983) and Keckler (1997) suggest that changes to the lateral spacing of a writing may be influenced by the speed at which the writing is produced rather than any conscious attempt to alter it. In both studies it was found that the more rapidly a disguised writing was executed, the more widely spaced it became; conversely, the slower the disguised execution, the more closely spaced it became (Jamieson, p.119; Keckler, p.156).

These findings implicitly suggest that any changes that occur to the spacing patterns which are due to a deliberate modification of speed or slant will necessarily be inconsistent because the disguiser will be unable to maintain these changes for any length of time.^{cv} This supports the claim made by Huber and Headrick (1999) that inconsistent spacing is among the principal distinguishing features of disguised writing (p.284).

But there is also a commonly held principle reiterated in the theoretical literature that spacing is an inconspicuous element of writing that will be overlooked by the disguiser (Harrison, 1966, p.371; Hooten, 1990, p.20; Dines, 1998, p.280; Morris, 2000, p.96), and there is some evidence to support this view. Indeed, Keckler (1997) reports that the majority of the ‘arrested felons’ he studied did not change their lateral spacing habits during disguise (p.156). Alford (1970), too, has found that none of the disguised writing samples he studied were ‘materially altered’ with regard to normal spacing habits, and he comments that ‘[e]ven persons possessing highly unusual and identifying [spacing] characteristics retained those idiosyncrasies in the disguised text writing’ (p.482); he concludes that ‘spacing characteristics are almost never tampered with by those seeking to mask their true writing identity’ (p.482).

2.2.3.6 Numerals

‘It is this writer’s observation,’ Conway (1959) remarks, ‘that the intentional distortion of numerals is somewhat less prevalent in questioned and disputed documents than the intentional disguise of cursive script or even handprinting’ (pp.70-71). The authorities are unanimous in their agreement that numbers that stand alone in a text, or are found within dates, times, addresses or telephone numbers, for example, will frequently remain

undisguised, even in texts that have been meticulously modified (Dines, 1998, p.131; Hayes, 2006, p.166; Sellers, 1937, p.884; Koppenhaver, 2002, p.92).

This is not, Conway maintains, because the alteration of numerals is any more complex to achieve than those modifications made to other handwritten characters, but simply because the disguiser will 'omit or neglect' to modify them in incriminating documents (p.73). The reason for this neglect, Hooten (1990) surmises, is because '[t]he anonymous writer does not often equate numbers [...] with general writing' (p.20); accordingly, it is theorized that the disguiser will fail to appreciate the individuality that he or she expresses in their number writing, as they do in other components of their handwriting and will 'erroneously' suppose that their figures will not be compared by the handwriting expert (Dines, 1998, p.279).

The individuality of numerals, it is claimed, will be evident in their design and formation, the speed at which they were written, the pressure and shading they exhibit, and their arrangement and positioning in relation to other numbers, words and symbols (Sellers, 1937, p.884; Conway, 1959, p.68; Hilton, 1982, pp.220-222; Dines, 1998, p.131). The commingling of these elements, Hilton (1982) insists, will impart such a unique and characteristic appearance to an individual's numerals that these can form 'the basis of identifications that are as convincing as those of signatures or cursive handwriting' (p.223).

Indeed, the literature cites two cases where numerals were critical to the identification of disguised writing and which led directly to the conviction and execution of two murderers: William Hickman and Bruno Hauptmann. Both writers failed to disguise the habitual way

they wrote their numerals in their anonymous letters and ransom notes, and these mistakes ultimately cost them their lives (Seller, 1937, p.119 and p.883).

Empirical research has yet to establish any solid data with regard to the disguise of numerals, and what little evidence there is appears to be somewhat contradictory. The findings from two studies accord well with the theories advanced in the experiential literature that numerals will rarely be disguised and will, therefore, provide valuable identification evidence (Conway, 1959, p.68). Kropinak (1965) has reported that in his study of disguised writing, the '[n]umerals in most cases remained unchanged and aided identification' (p.4), and Keckler (1997), too, observed that 91% of his subjects failed to disguise their numbers. Nevertheless, the results from the study conducted by Alford (1970) support exactly the opposite conclusion and suggest that writers are aware of the 'individuality of their number forms' and that many writers are able to modify these effectively (p.486). Nevertheless, it still remains the case that a proportion of Alford's subjects (30%) did not modify their numerals.

2.2.3.7 Proportion

There is a generally held principle in the experiential literature that the proportion of letters will remain constant and undisguised. Even when such elements as the size or slant of writing have been deliberately altered, it is said that the relationship between the constituent parts of a letter to that of its whole will not change from that which is habitual to the writer (Nickell, 1996, p.4; Ellen, 1997, p.32; Hayes, 2006, p.164). Indeed, Ellen (1997) states that a disguise made with the unaccustomed hand will tend to be made larger than the disguiser's natural writing (p.32), and Hayes has noted that more structurally

complex letters will be made larger in disguise to compensate for the disguiser's 'lack of skill' (p.163). Nonetheless, in spite of this size alteration, 'the same general features of [...] proportion' will be found in the writing (Ellen, p.32).

There are, however, certain proportions that the literature identifies as being of particular significance to the handwriting examiner:

2.2.3.7.1 Proportion of Capital Letters

Since capital letters are a very conspicuous feature of writing they are often targeted for modification by the disguiser. But the proportions of capitals will tend to remain the same as that found in the writer's normal, natural handwriting. (Hooten, 1990, p.19).

2.2.3.7.2 Zonal Proportions

Hayes (2006) draws attention to the three zones of writing and suggests that these will rarely be modified by those attempting disguise. The copy books that are often used as an aid to teach children how to write are typically divided into three sections by the drawing of four horizontal lines into which each letter of the alphabet is written. The top section is termed the *upper-zone*, the middle section is the *mid-zone* and the bottom section is called the *lower-zone*. Some letters are formed only in the mid-zone, some cross two zones and some three. Mid-zone letters, such as 'a', 'c', or 'e' rest on the baseline and have no strokes

rising above or below it. Letters such as 'b', 'd' and 'h' are formed in two zones: the body of each letter is in the mid-zone which rests on the baseline, but the letters also possess extender strokes that rise into the upper-zone. Similarly, letters such as 'g', 'p' 'q' and 'y' again have the body of each letter in the mid-zone, but they also have descending strokes that reach below the baseline into the lower-zone. A traditional lower-case 'f' can straddle three zones, or two if it is a more modern version of the letter, while the letters 'l' and 't' reside in both the upper and mid-zones, with the cross-bar of the letter 't' typically crossing on the existing or imaginary dividing line between the upper and mid- zones (Hayes, 2006, pp.30-31; Dines, 1998, pp.128-129).

When letters are formed, the ratios between zones will tend to be unconsciously, but consistently produced; consequently 'these will rarely [be] modified in disguised writing' (Hayes, 2006, p.163). It does not matter whether the overall size of the writing is made larger or smaller, the zonal ratios will always increase or decrease in direct proportion. Hayes believes that if modifications are attempted to one of the writing zones this 'may prove successful', but changes that are attempted to two or more zones will invariably fail, since they will disrupt the rhythm of the writing with concomitant negative impact on line quality (Hayes, 2006, p.32).

In addition, the disguiser's natural habits regarding certain combinations of upper-zone and mid-zone letters will remain 'especially stable and potentially identifiable' (Hayes, p.123) and, in particular, the ratio between the looped ascenders and the mid-zone of a writing will not be altered during disguise (Ellen, 1997, p.32).

2.2.3.7.3 Proportion between Upper and Lower-case Letters

Koppenhaver (2002) has noted that when the size of writing has been altered, deliberately or otherwise, the proportions between the upper-case and lower-case letters will 'generally remain the same' (p.89). However, there is no empirical evidence with which to support or reject this claim.

2.2.3.7.4 Upper and Lower Extensions

It is apparently very hard for a person to alter the relative length of up-strokes since 98% of Downey's subjects failed to disguise these features or, perhaps, were incapable of modifying them as a deliberate disguise tactic (1917, p.373).^{cvi} But to disguise the ratios of both the upper and lower extenders simultaneously is considered to be 'especially difficult' (Hayes, 2006, p.164). Tacitly, both Downey and Hayes agree that the relative length of these strokes will tend to remain habitual to the writer during disguise but that any changes that are made will be inconsistent.

More specifically, Hooten (1990) has drawn attention to the importance of examining the length proportions of the lower extensions of the small letters 'f' and 'p' and states that these 'are rarely changed' during the process of disguise from that which is habitual to the disguiser (p.19).

2.2.3.7.5 Size Ratios of Individual Names

It has been suggested that when a signature has been disguised, the size ratio of the individual names of which it is comprised 'will generally remain consistent' when compared with the disguiser's natural signature (Hayes, 2006, p.168). However, there is as yet no empirical evidence with which to support this claim.

2.2.4 Characteristic Writing Features of the Unaccustomed Hand

Although many of the features that are said to distinguish disguised writing will be observed in disguises made by the unaccustomed hand, sometimes referred to as the non-dominant hand, this method has been singled out in the literature since it is said to possess some features that are particularly characteristic of this method of disguise.

Mikels (1971) has observed that a 'peculiar smudge pattern', which is caused by the way in which the writing is made, can sometimes be observed in left hand writing when an ink or ball point pen is used. During the process of writing, the right hand will precede the written word, whereas the left handed writer must pass their hand over a newly written word in order to move on to write the next word. This can frequently cause the written line to smudge and the writing hand to collect deposits of ink which are then left on the paper as the hand slides downwards to begin the next line of writing (p82).

Conway (1959) has also noted that a naturally right handed person who uses their left hand to effect a disguise may produce ‘awkward counter-clockwise ovals and circles’ and that ‘clumsy left hand uncertainty’ will be found in the movement of the line in looped formations and curves (p.202). Unfortunately, Conway provides no further information on how this ‘uncertainty’ will be evidenced in the ink line, but it may be that such unnaturally executed handwriting will display, what Hayes (2006) has described as ‘trembling or jagged strokes’ (p.119).

Dines (1998) reiterates that the primary identifying feature of disguised writing made with the unaccustomed hand will be a palpable lack of skill in its execution which will be indicated by poor line quality and an erratic appearance in the written strokes (p.283). He cautions that similar errors may be displayed in genuine writing that has been awkwardly made, for whatever reason, but claims that the uneven appearance of disguised writing made with the non-dominant hand will be accompanied by an ‘extreme distortion of obvious features in the writing’ as evidenced by indistinguishable letter forms, tremor, varying slant and irregular baselines (pp.282).

PART II

Traced Forgery

3 TRACED FORGERY

‘If it were only sexier,’ Time Magazine wrote, ‘it might have rated recognition as the world’s oldest profession. Ever since human kind became literate, civilization has been bedevilled by the forger’s determination to deceive by mimicking the writing of others’ (May 16, 1983). Besides freehand imitation and those methods that involve the use of modern technology such as scanners, computers and printers (Koppenhaver, 2002, pp.128-130), traced forgery is a type of simulation that is said to be commonly encountered by the handwriting examiner (Ellen, 1997, p.53; Norwitch and Seiden, 2005, p.428).

Tracing has been described as the ‘simple forgery’ (Hartley, 1955, p.466), and certainly, compared with the complex questions of disguise, the issue of traced forgery appears to be one that is somewhat more straightforward for the handwriting examiner. This is not to suggest that tracing is not without its problems (see section 3.3), but it is generally accepted that this class of forgery is ‘somewhat less difficult than the detection of other types of forged signatures’ (Hilton, 1962, p.195. See also Osborn, 1929, p.326). Possibly, this is because the making of a traced forgery is, as Harrison (1967) has pointed out, essentially ‘a mechanical process [which] needs only a modicum of care to yield what at first sight appears to be an accurate though rather stilted copy of the genuine signature’ (p.106); it may also be that the forger, ‘cognizant of the fact that a superficial resemblance is often sufficient to fool his victim’ (Keyes, 1966, p.3) will not execute their tracing with the exacting care that is required to achieve a close approximation to the model writing. Indeed, the traced forgery ‘eludes detection under cursory examination more readily than

any other type' (Rhodes, 1934, p.48), which makes it, Lavay (1909) suggests, one of the 'most dangerous methods of forgery' (p.17) and is what '[t]he forger depends on [...] in order to ply his trade' (Koppenhaver, 2002, p.134). But irrespective of the degree of care that the forger devotes or fails to devote to the process of tracing, Baker (1955) maintains that a traced forgery will always be 'inferior' to the model it copies (p.271).

More specifically, Black (1962) has suggested that tracings will always contain errors by which they may be recognized, even if the forger's writing skills are superior to those possessed by his or her victim (p.111). With 'careful observation', therefore, traced forgeries 'are often more easily detected' than freehand simulations (Gupta, 1979, p.20; Blackburn, 1909, p.64), and their identification 'practically always possible' (Hilton, 1939, p.573).

Robert Lewis Stevenson and his stepson, Lloyd Osbourne, have portrayed the difficulties of producing a perfect forgery of another's signature in their novella, *The Wrong Box* (1889). As their protagonist, Morris Finsbury, scrutinizes his numerous but woeful attempts to produce a convincing freehand imitation of his uncle's signature, he wonders bleakly at his apparent 'incompetence':

It almost seems as if it was a talent that I didn't possess. [...] Well, there's nothing else but tracing possible. [...] Then he went to the window, and in the face of all John Street traced his uncle's signature. It was a poor thing at the best. 'But it must do,' said he [...] (pp.88-89).^{cvi}

This excerpt reflects a belief reiterated in the literature that tracing will tend to be the technique resorted to by those who doubt their ability to make convincing and undetectable freehand copies of another person's writing (Harrison, 1955, p.751; Keyes, 1966, p.3; Bradford and Bradford, 1992, p.304; Koppenhaver, 2002, p.28). The apparent readiness of many to choose tracing over other methods of forgery is not, perhaps, surprising; the tools of tracing are generally to be found quite readily, and many of us will have been taught the art of tracing from a very early age during our acquisition of handwriting (Cardaciotto, 1992, p.31). Accordingly, it is a technique that is considerably more familiar to us than that, for example, of free-hand simulation.

The process of learning to write tends to begin with the tracing of individual letters of the alphabet to facilitate the development of fine motor skills. Tracing is thought to establish solid familiarity of letter shapes and of the direction of the strokes that are used to construct each letter. The technique is also encouraged as a way of aiding the child to master the difficulties of holding a pencil or pen.^{cviii} Familiarity with tracing, Osborn (1929) claims, can lead 'inexperienced operators' to consider this method of forgery as the 'ideal' and most effective way in which to copy another person's writing (p.326). Lynch (1971) agrees, suggesting that since '[n]o 'artistic ability' or particular skill seems necessary, the end result should 'look just like' the genuine signature' (p.15). Certainly, by carefully tracing over the written lines of another, the forger can create a copy that will closely resemble the model writing in terms of its spacing, size, letter forms, ratios, slant and other characteristics that may be peculiar to the genuine writer (Keyes, 1966, p.3; Harrison, 1955, p.751).

Nonetheless, tracing is often criticized for being an ‘amateurish’ method of forgery (Lynch, 1971, p.15; Nickell, 1998, p.59) and its ensuing products dismissed as no more than clumsy, crude imitations (Osborn, 1929, p.326; Hilton, 1982, p.187; Rile, H.C., 2006, p.90). Indeed, Conway (1959) states unequivocally that traced forgeries will always fail to ‘pass muster as genuine when they are examined searchingly and intelligently and compared with authentic signatures’ (p.21).

In the United States and in the United Kingdom, forgery by tracing has a long history. *Kemp v. Mackrill*, 96 English Reports K.B. 827 (1754),^{ciX} the earliest reported court case in which the admission of expert comparison evidence was admitted under the common-law of England, concerned the attempted proof of forgery by tracing (Burdett and Farnham, 1904, p.870). It was conceived to be ‘impossible for any person, either by chance or with design’ to reproduce a number of signatures and dates ‘so exactly alike’ without their being traced copies (Burdett and Farnham, 1904, p.870). *Kemp v. Mackrill* established the principle, still held by document examiners today, that if questioned writings, usually signatures, coincide or superimpose exactly, the likelihood of their being traced from a single source is extremely high.

Another notorious case involved the 1632 Second Folio of Shakespeare’s works. The marginal notes and corrections that appeared in the Folio were at first accepted as contemporaneous, but in 1859, further investigation revealed the notations to be forgeries when it was discovered that inked-in ‘characters had been first traced in pencil and imperfectly rubbed out’ (Fitzgerald, 1886, p.281). There have also been two notable cases in the United States which are widely discussed in the literature^{cx} and held to be classic

examples of written traced forgery: the ‘celebrated’ Rice Will Case of 1903²⁵ (Osborn, 1929, p.207) and ‘[t]he most famous case of this nature,’ the Howland Will Case of 1868²⁶ (Burdett and Farnham,1904, p.870)^{cx}. In both instances, the proof of traced forgery was the central fact to be established.

But can it be said today that traced simulation is nothing more than an anachronistic technique of perpetrating forgery and one that should now be relegated to the annals of handwriting analysis history? A brief examination of the recent press suggests not. In 2008, the body responsible for managing and preserving the historical government and public records of Britain, the National Archives, found that ‘its reputation had been compromised’ by the fact that a number of documents in their archives, including a handwritten letter purportedly sent by the Duke of Windsor to Adolf Hitler, were confirmed by experts to be forgeries (Leppard, 2008). As early as 2000, suspicions had been aroused as to the authenticity of these documents which had formed the basis of a book by historian, Martin Allen: the man ultimately suspected of perpetrating the forgery. The letters and documents supported the claim that British intelligence agents murdered Himmler on the orders of Winston Churchill and ministers of the War Cabinet (Sanderson, 2005). However, on close examination, the forensic document analyst, Audrey Giles, confirmed that many of the signatures contained in the documents were, in fact, nothing more than ‘written over pencil tracings’ (Leppard, 2008).

While these events were unfolding, two further cases of traced forgery came to light. In June 2003, Jeanette Jackson discovered that her common law husband had died intestate

²⁵ *In re Rice*, 81 N.Y. App. Div. 223, 81 N.Y. S. 68, 1903.

²⁶ *Robinson v. Mandell*, 20 F. Cas. 1027 (C.C.D. Mass.) (No. 11,959) 1868.

and, fearing that her partner's entire estate would legally pass to his son by his first marriage, forged a will purporting to be his by tracing the signature on his passport (Smith, 2005). Only a month later, on the 22nd July, 2003, a man was found guilty of murdering his stepdaughter. It was proved that having killed the girl, he then 'bought tracing paper' and with it 'forged a letter by tracing her handwriting' in an effort to make his wife and the police believe that she had merely run away (Bruxelles, 2003).

The above examples notwithstanding, forgery by tracing is not a crime that is inevitably perpetrated by the individual. In a recent 'massive, systematic and organised fraud' (Mawrey Q.C, 2005, Judgement, p.4, §14),^{cxii} a number of Labour Party Candidates and their agents resorted to traced forgery in a postal vote fraud in an attempt to secure votes for themselves during the 2004 Birmingham City Council elections. In a 'vote-rigging factory' (Britten and Jones, 2005), 'literally thousands' of votes were forged (Mawrey Q.C, 2005, p.4, §14). After 'extensive document examination by handwriting experts' (Mawrey Q.C., 2005, p.45 §154), it was found that amongst other techniques, tracing paper had been used 'to copy real voters' signatures' so that the 'forgeries [would] look convincing' (Kennedy and Sherman, 2005).

It has been stated unequivocally that traced imitations will be 'rarely encountered' (Gupta, 1979, p.20). Even so, it would seem to be a technique that remains a convenient option for the modern forger and one to which they readily resort.

3.1 Traced Forgery Defined

All writers agree with the definition furnished by Osborn (1929) that a traced forgery ‘is the result of an attempt to transfer to a fraudulent document an exact facsimile of a genuine writing by some tracing process’ (p.326). Largely for reasons of practicality, forgery by tracing will typically be restricted to signatures or ‘unusually brief’ texts (Nickell, 1996, p.59); Ellen (1997) has commented that there have been cases where extended text has been traced for the purposes of deception but such instances are likely to remain rare (p.38). This is because the process of tracing requires a model writing that is ‘in the exact or approximate form of the desired reproduction’ (Ames, 1901, p.68), if it is not, then the forger faces the immense difficulty of obtaining genuine writing in sufficient quantities to enable him or her to trace the extended wording they require for their forgery (Ellen 1997, p.38). Tracing is, therefore, said to be generally more suited to, and ‘by far the most common method’ of, forging signatures (Harrison, 1955, p.750; Ellen, p.38, 1997; Hayes, 2006, p.143).^{cxiii}

3.2 Methods of Tracing

The literature identifies three main methods for tracing handwriting: 1) direct tracing, 2) indirect tracing and 3) mechanical tracing

3.2.1 Direct Tracing

By far the ‘simplest’ and most ‘classic’ technique of tracing (Harrison, 1966, p.380) is that accomplished by the direct overlay method whereby the document that is to receive the traced signature is placed over the genuinely written, or model signature. The outline of the signature is then traced directly onto the uppermost document in ink (Hilton, 1939, p.571; Conway, 1978, pp.20-21; Bradford and Bradford, 1992, p.304; Ellen, 1997, p.38; Vastrick, 2006, p.372). Typically, the overlaid papers will be backlit to increase the visibility of the model signature, and it is for this reason that the direct tracing method is often referred to as the *transmitted light process* (Keyes, 1966, p.6; Conway, 1959, p.20; Lynch, 1971, p.16; Hilton, 1982, p.186; Huber and Headrick, 1999, p.293), or the *light box* or *window method* (Jackson and Jackson, 2008, p.236). Back lighting is achieved either by holding both papers to ‘the ever available window’ (Conway, 1978, p.21), or by placing them upon some sort of light box; this could be a readymade device, such as that typically used in photography whereby an aluminium box containing a lamp is covered by an acrylic diffuser, or it might simply be a homemade contrivance consisting of, for example, a piece of glass positioned over a light bulb (Bradford and Bradford, 1992, p.304).

3.2.2 Indirect Tracing

Indirect or two-step tracing (Baker, 1955, p.260; Black, 1962, p.110; Hilton, 1962, p.196) describes any method of traced forgery which entails more than a single process to effect a counterfeit signature and involves the use of guidelines to aid the construction of the forgery. By whatever means the guidelines are made, they will ultimately be traced over in ink which is why this method of forgery is sometimes referred to as the trace-over method

(Jackson and Jackson, 2008, p.236). Several techniques for creating guidelines are mentioned in the literature:

3.2.2.1.1 *Pencil Guideline Technique*

This process has been labelled a ‘direct method’ of tracing by Baker (1955, pp.258-259), but since it involves two distinct parts it is here categorized as an *indirect* method. Using an original signature as a model, or a photocopy or facsimile of an authentic signature, the forger places the document on which the forgery is to appear over the model signature and simply traces its outline in pencil. The pencil guideline is subsequently drawn over in ink.

3.2.2.1.2 *Indented Guidelines*

This technique, described by Roberston (1991) as ‘[p]erhaps the crudest method of creating a tracing’ (p.153), is accomplished by placing the authentic model signature on top of the fraudulent document over the exact location in which the traced forgery is to appear. Whilst applying a heavy pressure, the forger traces over the model signature with a sharp implement or stylus to produce an indented impression of the signature on the document underneath. The indentation is then traced over in ink to complete the forgery (Brewster, 1932, p.121; Harrison, 1966, p.382; Conway, 1978, p.20; Bradford and Bradford, 1992, p.305; Rendell, 1994, p.13; Dines, 1998, p.271; Hayes, 2006, p.145)

3.2.2.1.3 *Pin Prick Guidelines*

Cardaciotto (1992) and Hayes (2006) both mention a form of tracing that uses a series of pin pricks to create a guideline. A genuine signature is placed on top of the document that is to receive the forged signature. The forger then gently pushes a pin through the outline of the signature to create tiny, indistinct holes on the document below. A pen is then used to ink-in the guideline holes, one to another, in order to produce an outline of the signature (Cardaciotto, p.31; Hayes, p.145). This is a somewhat clumsy method of tracing, and as such, is one that is 'rather uncommon' (Hayes, 2006), as 'it is unlikely that an accurate reproduction will be accomplished and the pin holes will be obvious in the new document' (p.145), particularly under magnification.

3.2.2.1.4 *Guidelines made by Transference Techniques*

By using tracing paper or, less commonly today, carbon paper, the outline of a target signature can be transferred to another document. The carbon process requires that the target signature is placed on top of a sheet or piece of carbon paper. Both the carbon paper and the signature are then placed on top of the document which is to bear the traced signature. The model signature is then over traced with a sharp implement to create a carbon impression of the signature on the lower document. The carbon guidelines are then inked-in to create the illusion of genuine writing (Hilton, 1939, p.571; Baker, 1955, p.260; Conway, 1959, pp.19-20; Keyes, 1966, p.3; Bradford and Bradford, 1992, p.304; Ellen, 1997, p.38).

Dines (1998) suggests that using tracing paper to copy writing will achieve a guideline that has 'a clearer outline' to that which has been made with carbon paper (p.271). Purpose made tracing paper, or paper that is sufficiently transparent to see through is placed over the writing or signature that is to be copied (Harrison, 1966, p.383). Using a very light pressure, a pencil is then used to draw the outline of the signature onto the tracing paper. In 1966, Harrison remarked that the advantage of this method of tracing is that as long as a gentle pressure is used, there will be no incriminating depressions on the model signature to indicate that tracing has occurred (p.383). However, while this may be true when only a superficial examination of the tracing is made, today, such depressions will easily be detected with the aid of an ESDA machine (see section 4.2.2). Once the tracing is complete, the forger will turn the tracing paper over and rub the reverse side of the traced signature with pencil to leave a coating of graphite. The tracing paper is then placed blackened side down on top of the document at the place in which the forged signature is to appear. The forger then traces over the signature on the tracing paper with a pencil or other sharp implement to create a graphite impression of the signature on the document below. The guideline is then inked-in and often an eraser is then used to remove any traces of graphite (Ames, 1901, p.68; Ellen, 1997, pp.38-39).

3.2.3 Mechanical Tracing

Keyes (1966) and Levinson (2002) discuss a third type of tracing, which is classified here as *mechanical tracing*. This term can be used for any tracing that is made using mechanical

aids, such as a Camera Lucida or Pantograph, or by using equipment such as photocopiers, scanners and printers (Keyes, pp.5-6; Levinson, p.49; Koppenhaver, 2002, pp.129-30). Although it is important to recognise that other methods of simulation exist, this research is concerned only with those forgeries made by handwriting; accordingly, mechanical tracing will not be treated here further.

3.3 Traced Forgery: The Difficulties of Examination

3.3.1 Identifying the Author of a Traced Forgery

In a recent textbook on forensic science, the author declares that '[t]he goal of forensic handwriting analysis is to answer questions about a suspicious document and determine authorship' (Bertino, 2008, p.282). But as it has been remarked, '[t]here is a distinct class of cases involving comparison of handwriting, in which the object and result of the comparison are precisely the opposite of those usually sought' (Burdett and Farnham (eds.) 1904, p.870). In cases of traced forgery, the major principle of identification, which states that '[w]riting can be identified as belonging to an individual when there are sufficient individual characteristics of writing and no basic structural differences when compared with known writing' (Koppenhaver, 2002, p.89), does not apply. Following a guideline, be it drawn or indented, 'has nothing to do with natural writing,' Ellen (1997) remarks (p.40); indeed, tracing is not, Conway (1978) states, a writing at all: 'Tracings are accomplished in a manner foreign to the writing processes. Consequently, the identifying data which exist in writings and by which they are identified are not present in tracings' (p.19). Harrison (1967) agrees that the identification of the perpetrator of a tracing is 'problematic', adding

that ‘in general it may safely be assumed that the authorship of a traced forgery has to be determined on grounds other than the direct comparison of handwriting’ (p.117).

3.3.2 The Problem of Recognizing Traced Forgery

‘Of all categories’, Dines (1998) asserts, a well-executed tracing that closely resembles a genuine model signature ‘is very difficult to determine’ (p.269). The ‘almost’ perfect coincidence of the tracing with its model, he suggests, can, on cursory observation, make the traced signature appear perfectly genuine (p.269). Hayes (2006) adds that if only one traced signature is made and no model signature is found, this will further increase the likelihood that the forgery will remain undetected (p.53).

In addition, it is not always possible, Slyter (1995) suggests, to prove that tracing was the specific technique used to perpetrate a handwritten forgery (p.28). A tracing may be ‘indistinguishable’ from a slowly written freehand simulation since both may possess a line quality that is similarly poor, and if the tracing has been made by the direct method, there will be no tell-tale guidelines to betray it (Ellen, 1997, p.54). Identifying a tracing becomes even more problematic ‘[i]f the victim’s exemplars show a poor writing skill so that the defined normal range of variation includes irregular pen speed, lifts, and even retouchings’ (Slyter, p.32). A traced forgery of unskilled writing may not be recognized as such since the usual indications that would identify it, such as poor line quality, may be wrongly attributed to the poor writing skill and individual characteristics of the writer (Kirk, 1952, p.500; Ellen, p.53).

4 CHARACTERISTICS OF TRACED FORGERY

4.1 The Causes of Traced Forgery Characteristics

‘[W]hile it is theoretically possible to produce a perfect forgery by tracing,’ Brewster (1932) reflects, in reality ‘the task is so exceedingly difficult as to be impossible’ (p.123). It is to be expected that a traced forgery will show a close correspondence with the model it copies in terms of its pictorial appearance, its size and proportions (Conway, 1959, p.21; Keyes, 1966, p.3), but while ‘[t]he forms may be quite correct [...] the execution as a rule is very bad’ (Osborn, 1946, p.336). The traced forgery, Osborn declares, is [t]he most obvious and unmistakable forgery’ (p.336) and Baker (1955) believes that it will always be inferior to the model it copies (p.271).

Three main reasons are given in the literature to explain the occurrence of certain faults in traced forgeries which can help identify them: 1) a lack of ability and/or determination on the part of the forger, 2) the mental and physical stress experienced by the forger while tracing, and 3) the actual process of tracing itself (Baker, 1955, p.271; Lynch, 1971, p.16; Robertson, 1991, p.152; Leung et al., 1993b, p.415).

‘In forgeries perpetrated by the aid of tracing,’ Ames (1901) states, ‘the internal evidence is more or less conclusive, according to the skill of the forger’ (p.69). Without a good deal of manual dexterity, it is unlikely that a forger will be able to create a tracing that is

sufficiently convincing to be accepted as genuine. Baker (1955) suggests that '[t]he quality of the tracing is controlled by the ability or skill of the tracer in following the formation of the genuine signature' (p.282); Leung et al. (1993b) agree but add that the success or failure of the forgery is also dependent upon the determination and drive of the forger (p.415).

Faults will occur in the writing line also as a consequence of the mental and physical conflict that is said to be experienced by the forger whilst tracing. It was reported in section 2.1 that there are more mental functions involved in handwriting than for most other tasks, and that any attempt to inhibit one's customary manner of writing will result in a certain degree of mental tension. Leung et al. (1993b) have reported that under experimental conditions, the tracing of an unfamiliar signature and, more surprisingly, the tracing of the subjects' own signatures, imposed stress on the subjects which affected the production of their tracings and therefore the overall quality of their forgeries. It is suggested that the deterioration in the execution of this type of forgery is because the demand on the psychological processes that govern performance is increased during the act of tracing due to the writer's need to concentrate on multiple tasks simultaneously (Kao et al., 1983).

The high degree of precision demanded by the process of tracing unnaturally requires the forger to focus concentration on the model writing, the movements of the hand and the motion of the pen (Robertson, 1991, p.152). These multiple tasks engage intensive involvement of the brain's central decision mechanisms and increase demand on visual feedback and processing because the writer has to continually reassess the unfamiliar model writing and adjust their tracing accordingly (Kao et al., p.75). This, Kao et al.

suggest, will result in an unconscious tensioning of the muscles which can cause faults to appear in the writing line.

Muscle tensioning will be further increased during tracing, Lynch (1971) believes, because all tracing methods force the writer to assume an 'awkward and unnatural writing position' (p.16) which leads, in turn, to awkward and unnaturally made writing. Accordingly, the tracing will be 'executed slowly and with deliberation' (p.16), which, Brewster (1932) adds, will result 'in a product that is drawn and laboured in appearance, and which has none of that freedom and fluency so characteristic of even a slowly written genuine signature' (p.121).

Tracing techniques of necessity do not permit the hand to rest comfortably upon the page or the eye to view the model writing unobscured. Irrespective of the method used, the unavoidably awkward process of tracing denies the writer the ability to write naturally and freely. This will adversely affect the qualitative nature of the written line (Nickell, 1996, p.59; Baker, 1955, p.272) such that the tracing will differ 'radically from a genuine writing' (Osborn, 1929, p.130). Next to the freedom or vitality, as it were, of natural writing, the tracing is, by contrast, lifeless.

A tracing 'ordinarily produced' necessarily forces the pen to follow unfamiliar paths so that it must be slowed or even stopped as constant attempts are made to discern the detail of the model writing to ensure that correct stroke directions are being followed and that correct letter forms are being made (Osborn, 1929, p.130; Robertson, 1991, p.152). A 'direct consequence' of these limitations is that the process of tracing will unavoidably degenerate

into little more than an act of drawing (Leung et al., 1993b, p.418) which is, Rhodes (1934) states emphatically, the ‘fatal disadvantage of the traced forgery’ (p.49). The characteristic drawn appearance of traced forgery is due to the lack of natural rhythm in the writing: ‘that harmonious recurrence of movement indicated by the free and fast pen stroke [...]’ (Baker, 1955, p.263).

As was discussed in sections 2.2.1 and 2.2.2, one of the first casualties of writing made by a pen heavily restricted, will tend to be rhythm: the element that is regarded by some handwriting examiners to be the very essence of a genuinely made script and the quintessential quality that ‘gives life to the writing’ (Baker, p.263). Regardless of whether a direct or indirect tracing technique is used, the restrictive nature of closely following the written line of another person while suppressing natural writing movements will inevitably inhibit a fluent, rhythmic style (Osborn, 1946, p.336; Robertson 1991, p.152), and this will lead to faults in the make-up of the tracing that can help the examiner to recognize the forgery.

‘The most minute detail of a document [...],’ Conway (1959) states, ‘may be the beacon which will light up the truth concerning that document’ (p.11), and it is generally agreed that there will be ‘sufficient indications’ present in a traced forgery to proclaim it as such (Kirk, 1952, p.500). Gupta (1979) suggests that the defects in a tracing will always be ‘present in such a gross manner that they rarely pass unnoticed by an expert’ (p.20). Nonetheless, Conway cautions that the observation of a single characteristic defect will not on its own prove that writing has been traced, but rather will be a ‘combination of these individualities with their accumulative significance in a handwriting which [will] serve [...] to identify it’ (Conway, 1959, p.53).

4.2 Identifying the Characteristics

The literature speaks of ‘typical’ or ‘textbook’ characteristic defects of the traced forgery (Hilton, 1939, p.572; Conway, 1959, p.186 and p.191; Leung et al., 1993b, p.423); but what exactly do these characteristics consist of, and is it possible to establish when and where in a tracing these faults will occur?

There is somewhat more information of a theoretical and anecdotal nature on the identification of the characteristics of traced forgeries than there is currently empirical knowledge, and only two research articles have specifically attempted to isolate the faults that are said to occur in traced writing (Herkt, 1986; Leung et al., 1993b). This lack of empirical work maybe due to the tacit, sometimes explicit,^{cxiv} conviction that is prevalent among writers that tracings will be sufficiently distinctive so as to be easily identifiable. They will not, however, always be so easily differentiated from freehand simulations.

It is apparent in the literature that many of the defects that are said to characterize traced forgeries are also those that are said to distinguish disguised writing and freehand simulations. Some writers even regard traced forgery as ‘a common form of simulation’ (Ellen, 1997, p.53). This, of course, raises the question of whether it is, in fact, possible to distinguish between a characteristic of disguise or simulation, and a characteristic of traced forgery. Huber and Headrick (1999) have stated that ‘there is no reliable line of distinction between skilful freehand simulations and tracings in all cases. Some of the defects may be the same, and tracings may diverge from the model as much as dexterous simulations’ (p.294). This question will be addressed more fully in Chapter 6 when evaluating the

empirical data that has been collected for this current research, but some writers have agreed, albeit anecdotally, that tracings will generally be inferior to most other forgeries since they will typically display less ‘vigour and spontaneity’ (Leung et al., 1993b, p.423) whilst containing more numerous and ‘more pronounced’ characteristic defects (Ames, 1901, p.72; Hilton, 1939, p.574; Hilton, 1962, p.195).

In order to avoid repetition, the traced characteristics that correspond with those that are described comprehensively in Chapter 2, *Characteristics of Disguise*, will not be further defined here, but observations will be made as to how these characteristics relate specifically to traced forgery. Those characteristics that are distinct to traced handwriting will be identified as such and described fully in the sections below.

4.2.1 Degenerated Line Quality

The first casualty of writing that has been imperfectly or unnaturally executed is said to be the appearance of the ink line. Whether applied to traced forgeries, disguised writing or freehand simulations, poor line quality is considered by many to be ‘[t]he most common symptom of forgery’ (Osborn, 1929, p.328) as well as ‘one of the most revealing characteristics of forgery’ (Harrison, 1955, p.754). But Hilton (1939) suggests that while the faults that appear in traced forgeries may be the same as those appearing in simulations, the tracings will ‘tend to contain [...] poorer duplication of the line quality than free-hand forgeries’ (p.574). Indeed, it has been stated that inferior line quality is the main characteristic by which a tracing can be identified (Cardaciotto, 1992, p.32). According to Baker (1955), ‘the adjustment to the same writing movement used in the original signature [is the] one important factor [...] which the tracer cannot master’ (1955, p.262).

All commentators highlight the importance of examining line quality in cases where tracing is suspected, but both Baker (1955) and Rendell (1994) agree that in the majority of traced forgeries, and particularly in those made by the transmitted light process, a meticulous handwriting examination will be unnecessary to expose them as such since an especially poor line quality will be clearly apparent (Baker, p.262; Rendell, p.13).

An examination of the movement of the pen and the manner in which the writing was produced is 'highly significant' in determining the 'quality of naturalness or artificiality in writing' (Osborn, 1929 p.328). Just as it is for disguised writing and freehand simulation, so, too, is it generally thought that the writer who attempts a tracing will fail to recognize the importance of the quality of the written line. It will typically be the case, therefore, that they will make no attempt to replicate this feature of the model writing and that involuntarily they will leave vital evidence in the ink line pointing to the fact that the writing is a forgery (Osborn, p.328).

That greater concentration is given by the tracer to the general form and pictorial effect of their model writing is supported by research conducted by Leung et al. (1993b), in which they found that 100% of the signatures traced by their 189 subjects contained characteristic features of degenerated line quality; these tracings 'were highlighted by the pressure of a slow measured stroke accompanied with hesitation, pen pause and [an] absence of vigor [sic] and spontaneity' (p.423).

Disruption to the smoothness of the ink line is said in the literature to be dependent upon the incidence of the following characteristics. The frequent occurrence of some or all of

these features in a disputed writing should alert the handwriting examiner to the possibility of traced forgery.

4.2.1.1 Speed and Pressure Variation

‘Writing speed cannot be measured precisely from the finished handwriting but can be interpreted in broad terms as slow, moderate, or rapid’ (Hilton, 1982, p.21). Slyter (1995) has stated that of all handwritten forgeries, tracing is the most slowly executed and that an examination of the elements of speed will be sufficient to distinguish it from genuine writing (p.15). Tracings will always tend to ‘wear the chains of slow, unnatural [..] movement’ (Conway, 1978, p.21), and most writers agree that such laborious production will produce an abnormally heavy, unvaried pressure in the writing line and an absence of shading (Vastrick, 1982, p.191; Hilton, 1982, p.187; Cardaciotto, 1992, p.32; Bradford and Bradford, 1992, p.305; Ellen, 1997, p.39; Dines, 1998, p.270; Huber and Headrick, 1999, p.292; Hayes, 2006, p.144).

Unvaried pressure will be apparent in traced writing as uniformly dark strokes, which are due to larger deposits of ink being made on the paper as greater pressure is applied to the pen, and a lack of fine pen lines (Fraser, 1894, p.58; Nickell, 1996, p.69). A handwriting displaying such an appearance will be in stark contrast to that which has been made naturally and which is generally characterised ‘by light or hairline upstrokes and shaded or heavy down strokes’ (Nickell, 1996, p.69). Shading has been described as a variation in the width of strokes caused by the amount of conscious or unconscious pressure that is applied to the pen (Lafone, 2005, p.xxii); a natural rhythmic handwriting will generally display variation in its line widths which will become wider as pressure is applied to the pen and

narrower where pressure is reduced. Tracings, however, will show no such variation in the widths of its lines, the strokes 'always having the same breadth' (Mathyer, 1961, p.125), and this lack of variation will be 'particularly' noticeable in the up and down strokes (Osborn, 1946, p.336).

Although Kao et al. (1982; 1983) were not seeking to address handwriting forgery specifically in their two studies, the results they found provide important empirical information with which to support the claim that a traced forgery will characteristically exhibit a slow speed and consistently heavy pen pressure. Their first study examined whether a relationship existed between writing pressure and writing performance. They found that when a writing was traced, the pressure of that writing was unaffected by the complexity of the writing task. In order to test these findings, Kao et al. conducted a further study which compared traced handwriting with freehand writing. The study concluded that contrary to freehand writing, where pen pressure increases and pen speed decreases as the complexity of the writing task becomes greater, the pen pressure in tracings tends to become uniformly heavy, no matter how complex the writing task might be. In addition, Kao et al. tacitly submit that the time it takes to make any tracing will tend to be uniformly slow (p.72).

These findings are consistent with those reported by Leung et al. (1993b) in their study which was specifically designed to investigate forgery by tracing. Volunteers were asked to perform three main tasks: 1) to trace twenty-one handwriting symbols containing specific target features, 2) to sign their own signature naturally and then to trace it, and 3) to trace a signature that was unfamiliar to them (p.414). A very large majority of just over 94% of the volunteers failed to reproduce the difference in thickness of the horizontal and vertical

strokes in certain target symbols, which is suggestive of a slow pen movement and heavy pressure (p.415). Indeed, it was found that a ‘great majority of the participants used considerably longer time - a multiple factor of over ten times the original time, even in tracing their own signature’ (p.422). This study strengthens the ‘general observation’ that pen movement slows considerably during the act of tracing, and that pressure patterns become more uniform and less varied than the corresponding pressure patterns of the model writing (p.420).

4.2.1.2 Retouching and Overwriting

‘[T]he traced forgery [...] is more retouched than the freehand specimen,’ Rhodes (1934) observes (p.71), although his statement is qualified by Dines (1998) who suggests that tracings will ‘*probably* contain corrections [and] touch-ups’ (p.269. Italics added). Whatever the actual frequency of the characteristic might be, it is, nevertheless, generally agreed upon in the literature that the presence of corrected or touched up strokes is a common identifying characteristic of traced forgery (Robertson, 1991, p.152; Slyter, 1995, p.26; Hayes, 2006, p.146).

As it is likely that the natural shading in the model writing will be omitted from the strokes of the tracing, Rhodes (1934) maintains that forgers writing with an ink pen will commonly superimpose or touch-in shading after the overall tracing has been completed in an effort to simulate the wider strokes that are evident in the model writing (p.71). In addition, Slyter (1995) has noticed that retracing and retouching will be made ‘to extend a character or stroke to better fit the model’ (p.32), but also, Hilton (1939) adds, ‘to perfect [...] letter formation’ (p.573).^{cxv} Ames (1901) has also observed that because the more ‘delicate

features of the original writing are essentially obscured by the opaqueness of two sheets of paper' these features may be omitted from the final tracing, and it will often happen that 'their absence is [...] supplied through force of habit, by equally delicate unconscious characteristics from the writing of the forger' (p.70).

Connecting lines in particular are 'difficult to trace', Baker (1955) has observed, 'because of their fineness, and any retouching or attempted improvement instantly exposes the fraud' (p.264). Errors will often be made in a tracing because the forger 'has not understood the normal flow of the movements' which serve to make up the model writing. Consequently, the tracer will attempt to make small repairs to the ink line to improve the overall appearance of their tracing (Mathyer, 1961, p.125).

Repairs will also be made to correct or conceal imperfections in the writing line that were the result of the writer having paused their pen briefly on the paper while they reviewed and planned 'the ensuing course to be taken by the pen' (Huber and Headrick, 1999, p.292. See also section 4.2.1.3). Such retouching, Slyter (1995) insists, is a 'strong indication' of tracing (p.32), and if it is found, as is sometimes the case, that the retouching has been made with a stroke that moves in the opposite direction to that of the model writing, this can provide even more striking evidence of tracing (Hilton, 1982, p.187; Hayes, 2006, p.146).

There are, however, no empirical studies that provide any meaningful data on the frequency of retouching or overwriting in tracings with which to substantiate the claims made in the experiential literature. Herkt (1986) has observed that 'patching' occurred in

74% of the samples that he examined in his study of signature forgery (p.265).^{cxvi} However, his results incorporate the findings for both freehand and traced forgeries, so that it is not possible to isolate the proportion of traced samples that exhibited this characteristic. He did, however, report that ‘some’ of the traced forgeries he studied that had been made using the transmitted light process ‘subsequently had to be patched up’ since the direction of the line had been mis-traced (p.264).

4.2.1.3 Hesitation Marks

It is generally agreed in the literature that the ink line of a traced forgery will typically display indications that the pen has hesitated or stopped during its production (Brewster, 1932, p.123; Haggag, 1972, p.86; Hilton, 1982, p.187). This will be evidenced, Dines (1998) suggests, by ‘ink blotches where the pen has rested’ momentarily on the page (p.270).

Marks of hesitation will tend to occur in places that would in genuine writing be considered unusual, such as in the middle of a stroke that would typically be made in one continuous movement. Osborn (1929) has observed that hesitation marks will tend to be exhibited ‘in a more pronounced manner than simulations’, though just how much this characteristic will be in evidence will depend, he admits, ‘upon the specific process of tracing employed and the skill of the operator’ involved (pp.327-328).

It is claimed that the forger will frequently pause their pen to compare their tracing with the model writing (Osborn, 1929, p.130; Robertson, 1991, p.152). Often this will be observed where more complex writing movements are necessary, such as when a reverse movement

of the pen line is necessary, or to reflect upon the correct direction of the line as the pen forms one letter and moves to the next (Baker, 1955, p.258; Hilton, 1982, p.187). But it is also said that hesitation will occur as a natural consequence of any tracing process that obscures, to some extent, the model writing; when this happens, the tracer may pause their writing without lifting the pen to try to discern the detail of the model writing underneath and in so doing, leave a tell-tale mark which can signify the fact (Mathyer, 1961, p.125).

In view of the quantity of anecdotal and descriptive information surrounding the concept of hesitation, it is somewhat surprising that only one empirical study has addressed this issue in any detail. Leung et al. (1993b) have reported that the extent to which writers hesitated when tracing their own signature or when tracing the unfamiliar signature of another person was very similar; in both cases the writers became 'more hesitant' than when they wrote naturally and that points of hesitation increased. Nonetheless, it was observed that there was 'evidence of longer hesitation' when subjects traced unfamiliar signatures (p.420). However, the overall statistical results provided by this study combine the findings for 'hesitation', 'pen-lift' and 'pen pause' (p.422) so that it is not possible to extract data specifically relating to instances of hesitation. Moreover, the terms hesitation and pen-pause are often used synonymously in the literature and since Leung et al. do not define their terms we cannot be sure of the distinctions, if any, that they make between them.

4.2.1.4 Pen-Lift

According to Nickell (1996) and others, traced forgery will be characterized by 'an overabundance of pen lifts and/or by pen lifts at incorrect places' (p.70; Mathyer, 1961, p.125; Robertson, 1991, p.152). The concept of pen-lift is closely connected to that of

hesitation in that they both frequently interrupt the momentum of writing in order to ‘provide the individual with a momentary opportunity to review and to plan the ensuing course to be taken by the pen’ (Huber and Headrick, 1999, p.292). But whereas hesitation is said to be a pause whereby the pen is kept in contact with the paper, pen-lift, as the name suggests, is where the pen is entirely removed from the surface of the page but is returned to the point of removal with ‘some care and accuracy in the subsequent application of the instrument to the paper’ (Huber and Headrick, p.292). Just as they are in freehand simulations, pen-lifts are considered unnatural if they are observed in the middle of what should be continuous or curving strokes (Brewster, 1932, p.123; Slyter, 1995, pp.15 and 26). It has also been reported that if a forger notices their pen-lift, they will tend to try to cover these up by retouching the strokes concerned (Osborn, 1929, p.331), thereby creating yet further evidence of forgery.

Only two researchers have attempted to measure the occurrence of pen-lift in traced forgeries. As was mentioned in section 4.2.1.3, Leung et al. (1993b) have reported that instances of pen-lift, pen-pause and hesitation increased during the tracing of both familiar and unfamiliar signatures (p.420), but there is no data that relates specifically to the incidence of pen-lift. Similarly, Herkt (1986) reports that ‘breaks’ were observed in the samples of forged signatures he obtained, but he fails to define exactly what is meant by ‘breaks’ (p.265). Furthermore, his findings for both simulated and traced forgeries are combined, and his statistics for ‘breaks’ are included with those for ‘shakiness’ and ‘patching’ so that it is not possible to derive any meaningful data from this study with which to confirm or deny anecdotal observation.

4.2.1.5 Blunt Ends

As it is for other types of deviant writing, a blunted or flattened appearance at the beginning and at the ends of strokes can be an indicator of traced forgery (Bradford and Bradford, 1992, pp.306-307; Nickell, 1996, p.60). It is said that a lack of tapering strokes is symptomatic of the slow, deliberate execution with which tracings are produced (Lynch, 1971, p.16; Hayes, 2006, p.124), and certain strokes, Quirke (1930) writes, are more susceptible to this characteristic alteration. The terminal strokes in particular, he suggests, ‘do not taper, but continue with undiminished thickness to the end, where they often increase in width at the last, ending in a knob, or perhaps a ‘fish-tail’’ (p.153). Others agree that blunt ends will be particularly observed in the final strokes of a tracing but add that they can also be found in the initial strokes (Brewster, 1932, p.123; Cardaciotto, 1992, p.32; Hayes, 2006, p.145).

According to Harrison (1963b), traced forgery that has been constructed with an indented guideline will tend to display blunt ends in places where the tracer has failed to ink in the guideline to the extreme end of the indented groove. If this is noticed by the forger and an attempt is made by them to rectify the error by adding to the stroke, a characteristic ‘blunting of the line endings’ will result (p.175).

Empirical evidence on the nature and frequency of this feature of traced forgery is practically non-existent; Leung et al. (1993b) do not make specific reference to this most ‘textbook [of] tracing characteristics’ (Vastrick, 1982, p.191) in their research paper, but do report that the traced samples that they examined were produced slowly with restricted motion which resulted in ‘the various defects of tracing, some of which coincide with those

of simulation' (p.423). Mention is also made of the 'characteristic features associated with traced forgeries which have been described in detail in standard texts on document and handwriting examinations' (p.413). Since the 'standard texts' to which Leung et al. refer are the works of Hilton (1982), Osborn (1929) and Harrison (1966) who have all recognized blunt ends as being a characteristic trait of both simulated and traced forgery, it can be speculated that blunt ends were apparent in the traced samples examined in Leung et al.'s research; however, nowhere is this explicitly stated by them.

4.2.1.6 Tremor

When a forensic handwriting examiner provides expert evidence about a suspected traced forgery, '[e]mphasis should be placed on tremor' (Bradford and Bradford, 1992, p.309). Most writers agree that one of the key indicators of traced forgery is the appearance of tremor in the writing line (Brewster, 1932, p.123; Hilton, 1939, p.573; Osborn, 1946, p.336; Cardaciotto, 1992, p.32; Dines, 1998, p.270). These oscillations or 'irregular, shaking strokes' (Hilton, 1982, p.21) cause a marked deterioration in the written line and are the result of the tracing having been made slowly (Lafone, 2005, p.xxiv). Robertson (1991) and Cardaciotto (1992) suggest that 'fine tremor' is particularly significant in determining whether a writing has been traced (Robertson, p.169; Cardaciotto, p.32), but cautions that it may be so subtle as to be 'barely perceptible until photographically enlarged' (p.169). However, these observations are contradicted by Hayes (2006) who maintains that 'nearly every case' of traced forgery 'will evidence gross tremor' (p.144). It seems likely, however, that instances of both kinds will tend to occur.

The presence of tremor in the writing line is said to be a defining characteristic of forgery that is shared principally with freehand simulations, although '[t]racings probably tend to contain [...] more line tremors than free-hand forgeries' (Hilton, 1939, p.574). However, the position in which tremor is found appears to be as important as the amount of tremor observed; Bradford and Bradford (1992) claim that if tremor is displayed in the 'pickup' or initial strokes of a suspected tracing, this will be of particular evidential value (p.158).

The concept of tremor can prove to be doubly problematic for the tracer. Not only will tremor tend to be caused involuntarily during the tracing process, but if the model writing contains the natural fine tremor of the ill, infirm or elderly, it will be 'almost impossible by the tracing method successfully to imitate [it]' (Osborn, 1929, p.329). 'Genuine tremor' claims Slyter (1995), 'is as difficult to imitate as genuine writing movements', and even if tremor is involuntarily introduced into the tracing, the forgery will still reveal a 'smoother, better controlled pen handling' than will be seen in the genuine model writing (p.32). When such an incongruous finding is encountered, it will indubitably point to the artificiality of the writing. Moreover, if tremor is observed in a suspected tracing together with carefully made patching, this should especially be 'viewed with suspicion since a [genuine] trembling hand is not likely to administer careful patching' (Dines, 1998, p.140).

That tremor is an important element of traced forgery is borne out by the research conducted by Leung et al. (1993b). Here it was found that 'over 97%' of the traced signatures examined contained strokes with obvious tremor (p.420). Herkt (1986) has also observed 'shakiness' in the written lines of the forgeries his subjects produced, including those made by tracing (p.265). However, as has been mentioned previously, Herkt fails to

distinguish between freehand simulations and traced forgery in his tabulated results, so that it is not possible to extract from his data any precise information relating solely to tracing.

4.2.1.7 Acute Angles

Some commentators have noticed that tracings will often display acute or ‘inappropriate’ angles in place of the smoothly curving strokes that tend to be found in naturally written scripts (Baker, 1955, pp.257-258; Robertson, 1991, p.152). An explanation for this is proposed by Nickell who, in discussing the characteristics of forgery generally, suggests that ‘[a] lack of certainty in the direction a stroke should go may result in abrupt shifts in the movement of the line, thus giving a kinked [and therefore angular] appearance to a line that should instead be smoothly curved’ (p.69). Brewster (1932) agrees, observing that a traced forgery will display frequent changes in the path of what should be a straight stroke or rounded flowing curve (p.123). There is, however, no evidence beyond the anecdotal that can substantiate such observations.

4.2.1.8 Serrated Line Edges

A serrated or ragged line edge is a characteristic of traced forgery that has been observed by only one individual; Quirke (1930) has reported that the outside edges of a traced stroke will often appear uneven,^{cxvii} and he rather charmingly likens this appearance to the ‘rugged coast-line’ on a map. Although Quirke does not explicitly make the distinction, it would appear from his description that this is an element that differs from the tremor of tracing in that the main body of the stroke will remain smooth but ‘serrations’ will be

evident ‘on either side’ of it, imparting a rough appearance to the line. Tremor, on the other hand, is an oscillation of the entire ink line, including the main body and outside edges.

4.2.2 Evidence of Guidelines

‘Where traced forgeries are concerned the most devastating attack which can be made on their authenticity is to demonstrate the presence therein of a guideline or traces of a guideline which has been wholly or partially erased’ (Harrison, 1966, p.390). With the exception of tracings that are made using a direct technique, it is unanimously agreed upon in the literature that the presence of guidelines is strongly indicative of the tracing process; indeed, many consider the discovery of guidelines in a suspected writing as the primary factor that distinguishes a traced forgery from genuine writing and sets it apart from other written forgeries (Frazer, 1894; Osborn, 1929; Conway, 1978; Bradford and Bradford, 1992; Ellen, 1997; Huber and Headrick, 1999).

It will be ‘almost invariably found’ that the pencil guidelines used to make a tracing will be ‘visible here and there outside the ink line’ (Brewster, 1932, p.121), and that tracings made with the aid of carbon paper ‘are usually readily recognizable as such [...] by the double tracks of the carbon outline’ (Conway, 1978, pp.19-20) which create what Dines (1998) has referred to as a ‘halo’ effect (p.271). Low power magnification should be sufficient to detect the presence of carbon, pencil or tracing paper guidelines (Ellen, 1997, p.39) but they can also be exposed by the use of infra-red lighting which will show the guidelines ‘free of the overlying ink’ (Harrison, 1955, p.175).

But guideline evidence may consist of only microscopic particles of the tracing medium used, such as graphite residue from pencil leads^{cxviii} or carbon from carbon paper, which may be left ‘on the edges’ of the strokes that overwrite the guideline (Baker, 1955, p.260) or become ‘intermingled with the ink’ (Harrison, 1955, p.751); but in any case, enlargement of the suspect tracing should reveal all such fine deposits. Magnification will also ‘inevitably disclose’ the presence of any part of the guideline that has been left uncovered during the process of inking-in, and this will, it is said, occur typically on the initial and end strokes of the guideline, as well as on its curves and angles (Harrison, 1955, p.751; Baker, 1955, p.264; Lynch, 1971, p.17). A failure to thoroughly ink-in all parts of the guideline will occur, Lynch suggests, because it is ‘virtually an impossibility to absolutely adhere to the drawn outline’ (p.17).

Similarly, Robertson (1991) claims that ‘[i]t is all but impossible for even the steadiest hand to follow precisely the path of [...] indented impressions’ (p.153). This fact notwithstanding, it is likely that there will be no obviously visible signs of an indented guideline such as will tend to be the case when guidelines are made with pencil or carbon paper (Brewster, 1932, p.121). However, with the aid of an Electro-Static Detection Apparatus (ESDA)^{cxix} or by using the somewhat more rudimentary method of an oblique light source, the presence of any depressions in the paper surface that run alongside the ink line can be made visible. This ‘double-tracking’ provides compelling evidence of tracing since it reveals ‘where the pen has strayed from the original outline’ (Lynch, 1971, p.17). Using an electrostatic charge and fine carbon granules, ESDA has the ability to reveal ‘a text beneath the surface that tells the story of how the fabricated text was created’ and can reveal ‘indentations almost as effectively as carbon paper’ (Davis, 1994, p.80). Raised or indented sections of the paper surface will also be shown up ‘in strong relief’ when a

strong light source is placed at an acute angle to the paper surface. An examination of the reverse side of the suspect document using the oblique light technique can also reveal ‘the presence of [...] double-tracking’ (Lynch, p.17).

‘Most traced forgeries,’ wrote Harrison (1964), ‘are left with no attempt being made to erase the guide line. The forger is usually so pleased with his handiwork – because there is no doubt that a careful tracing looks very like the real thing – that the possibility of its being scrutinised under magnification seems to cause him little concern’ (p.110). Nevertheless, some forgers will endeavour to eradicate visible traces of their guidelines to remove all suspicion of crime (Dines, 1998, p.271), but such attempts will, in fact, provide further compelling evidence of forgery. Writers agree that irrespective of whether guidelines are made by pencil or carbon paper, any attempt to rub them out with an eraser will seriously disrupt the fibres of the surface of the paper and may cause the tracing to smudge (Harrison, 1955, p.751; Hilton, 1982, p.188; Ellen, 1997, p.39). ‘There is nothing’ Harrison warns, ‘so likely to cause suspicion as signs of abrasion in the immediate neighbourhood of a signature’ (p.751). Any attempt to erase a guideline will tend to cause the overlying ink to become ‘cracked, broken, rubbed or worn away’ (Osborn, 1946, p.337) as well as causing the ink line to ‘dull [...] in a characteristic way’ (Hilton, p.188). Writers also agree that even when the erasing has been carefully performed, deposits of carbon or graphite may still remain on the page and that ‘residual specks of the eraser material’ may be found ‘caught in the interstices’ of the paper fibres (Lynch, 1971, p.17; Hilton, 1982, p.188). On those occasions when traces of carbon or graphite have been thoroughly erased, Hilton (1982) has noticed that ‘a slight indentation from the pressure of tracing’ may still remain from the original outline (p.188). Harrison (1966) also observes that ‘the most

thorough erasure' will occur in the middle of a traced signature, with less meticulous care occurring at its ends (pp.384-385).

Empirical evidence relating to guideline characteristics is scant. The one study that is available suggests that tracings made with the aid of guidelines will be readily identifiable as such, since evidence of the guidelines will remain. In his study of signature forgery, Herkt (1986) found that '[a]ll the forgeries completed with the aid of some form of guideline exhibited clear evidence of this fact' (p.264).

4.2.3 Superimposition

The oft-quoted maxim, 'Nature never repeats itself'^{cxx} is popularly accepted as an axiomatic or self-evident truth^{cxxi} and is one that has been frequently adopted by those seeking to reinforce the significance that they attribute to certain forensic disciplines and to the evidence that these disciplines generate (Thornton, 1986, p.399; McRoberts, 1996, pp.1-3). This 'universal law of nature' can appropriately be applied to handwriting, claims Dines (1998), in that 'no two [writings] are identical when written freely' (p.61). This conviction lies at the ideological core of forensic handwriting examination, and is '[t]he basic principle upon which handwritings are classified, indexed, and identified' (Quirke, 1930, p.1).^{cxxii}

The assumption of uniqueness has been extended in the literature beyond founding principles to apply to the specific issue of traced forgery. Dines states unequivocally that no two writings can be identical, but adds that '[t]racing could be the exception to this rule'

(p.61). The ‘primary evidence of spuriousness in a tracing’ Huber and Headrick (1999) declare, ‘is its correspondence to the model from which it was created or the correspondence of a number of tracings to one another’ (p.292). When placed in juxtaposition, naturally made writing and signatures will not coincide exactly in every detail, ‘even if they are the executions of a well-practised writer’ (p.292). In particular, when small punctuation marks and ‘i’ dots are found to perfectly correspond in position and form, Osborn (1929) remarks, this ‘may be almost conclusive evidence of forgery’ (p.342).

Mathyer (1961) has stressed the importance of recognizing exact duplication in a suspected tracing, stating that if two signatures superimpose exactly ‘one of them must be a [...] traced forgery (unless they are both traced forgeries of one single model!)’ (p.129).^{cxxiii} Haggag (1972) also reports a case in which his conclusion that a suspect signature was traced was based, in large part, on the fact that when the questioned signature and the model signature were superimposed, they were ‘found to be absolutely identical’ (p.87).

‘[A] very convincing method of proving tracing’ Baker (1955) suggests, is to demonstrate by measurement the perfect coincidence of the position on the paper between a disputed signature and a suspected model. If two or more signatures can be proved to be ‘equidistant from the edges of the paper or some other fixed point’, this should be considered as ‘strong evidence that one signature was traced from the other’ since two naturally written signatures will ‘very seldom’ be found to be identically arranged on separate pages (pp.267-268).

Claims of exact duplication notwithstanding, Robertson (1991) and others caution that '[t]raced writings are rarely exact replicas' of the model writing they copy (p.152).^{cxxiv} 'It is', Brewster (1932) suggests, 'impossible to make a tracing of a signature so that it will be a microscopically exact facsimile of the original' (p.125). Nevertheless, it will be the case, others acknowledge, that the majority of traced writings will possess 'too many identical characteristics to be normal' (Bradford and Bradford, 1992, p.306). Brewster agrees, adding that a tracing and its model will show such close coincidence in the 'position and extent of all the strokes' that it will 'force one to the conclusion' that one of the writings has been traced from the other (p.125). But what if more than one tracing has been made from a common model? In this case, Harrison (1966) advises, 'proof of forgery is generally simple, for whilst the odds against two genuine signatures being replicas are very great, the chance that a number of replicas are anything but tracings are infinitesimally small' (Harrison, 1966, p.397).

Slyter (1995), however, advances an alternative view: he argues that it is, on the contrary, quite possible that some writers, particularly those 'who sign with a dominant rhythm pattern', will produce signatures that 'match up very closely' when superimposed (p.28). Osborn (1929) disagrees, stating that it would, no doubt be possible from a comparison of 'thousands of signatures' to discover 'some that are quite similar to each other, but if the attempt is made to find two of these similar signatures written *in succession* the search becomes [...] more difficult, and if three or four practically identical successive signatures are looked for, as for example on the same document [...] they cannot be found' (p.345). Osborn concludes that a traced forgery will only ever coincide approximately to the writing it copies, and advises that '[i]n considering the force of identity as evidence of forgery' it is

important to remember that ‘no traced imitation of a model will be an exact facsimile of it’ (p.346).

From their experimental observations of handwritten tracings, Leung et al. (1993b) found that ‘the majority of traced samples exhibited high percentages of superimposability’ (p.418). This finding is, perhaps, unsurprising when it is considered that tracing is a technique that is resorted to when the general form and outline of the model writing is to be reproduced as exactly as possible (Osborn, 1929, p.130). However, the study produced some interesting findings relating to the tracing of semicircles and those lines containing abrupt, alternate right and left turns, or zig-zags. Traced semicircles were found to exhibit a ‘higher superimposability’ than the tracings of zig-zag lines and the researchers concluded that curved strokes are ‘easier to forge’ (p.418). It is conjectured that the irregular nature of the zig-zag strokes caused a higher degree of uncertainty in the writers’ minds as to the ‘exact course’ that the pen should travel and that this resulted in less accuracy being made in their tracings of these strokes (p.418). Leung et al.’s results suggest that during the examination of suspected tracings, the close coincidence of semi-circular strokes should be weighed against the degree of correspondence, or lack of it, of any zig-zag formations.

Leung et al. (1993b) conclude that the probability of a signature having being produced by tracing is directly proportional to its coincidence with the suspected model (p.418). They explain that:

[I]f two or more signatures have 50% of the total lengths of their component strokes overlapping one another, then there is a high probability that one of the signatures is genuine and has been used as the model for tracing the other signature(s); or, the signatures are all traced forgeries deriving from the same genuine model signature (pp.423-4).

Nevertheless, and in accordance with Osborn (1929), the researchers imply that an opinion of traced forgery should not depend upon superimposition alone, but should be reinforced by the presence of other evidence.

4.2.4 Incorrect Model Choice and the Duplication of Errors

Baker (1955) has stated that '[e]very signature has a date and the signatures written at different dates frequently show variations and changes which are easily noticeable to the observer' (p.264). Changes in handwriting can occur because of natural ageing or because of disability or illness; it can also be affected by the medication or stimulants that a writer may be taking at the time of their writing. 'Many writers', Osborn (1929) insists, 'are not aware of the fact that even a few years, especially with those of advanced age, may make a great change in a signature' (p.336). It is also the case that writers will sometimes use different signatures or writing for different occasions: some might use a longer version of their name for official documents, for example, but prefer to use only their initials and surname for receipt of goods dockets signed at the door (Nickell, 1996, p71). The forger, claims Hilton (1939), will give 'apparently little thought' to their choice of model which can prove fatal to their subsequent tracing, and '[s]hould this standard be of a sufficiently earlier or later date than that of the forged document, it is conceivable that its

characteristics may vary sufficiently from those of the genuine writing at the document date as to cast suspicion on even the best of tracings' (pp.572-573).

Osborn (1929) has also noted that a forger will sometimes inadvertently use a model writing that contains 'accidental and unique' errors and reproduce these in their tracing 'with the utmost care and fidelity' (p.343). The presence of such flaws in a questioned writing, he states, and their duplication in other writings will serve as 'very convincing evidence of forgery' (p.343).

4.2.5 Omission of Fine Detail

It is generally agreed that many of the delicate features displayed in the model writing will be omitted from the traced forgery (Ames, 1901, pp.69-70; Hilton, 1939, p.573; Bradford and Bradford, 1992, p.309). A combination of materials is necessary to produce or construct a tracing of genuine writing, and these materials will inevitably come between the model writing and the document upon which the copy is to be made. The process of overlaying therefore tends to obscure small but important elements of the genuine writing which will then be omitted from the traced copy (Black, 1962, p.110). Tracings made with the aid of tracing paper or carbon paper are, Harrison (1966) states, 'twice removed' from the model writing and are, therefore, all the more likely to omit some or all of the fine detail of the genuine writing (p.383). Hilton (1982) adds that '[e]ven with a strong light and thin paper, some of the less conspicuous details of the model signature are not clear to the imitator as he follows the outline, and with the usual weights of paper and weaker light sources, even a greater number of details are omitted because of oversight' (pp.186-187).

Black has noticed that letter form detail and stroke sequences will be the elements of a genuine writing that will most often be omitted in a tracing (p.110), while Ellen (1997) suggests that forgers will tend to leave out any inconspicuous ‘dots’ that the model writing may contain (p.39); Osborn (1929) adds that the ‘i’ dots and punctuation marks of a genuine writing are also liable to be excluded from any subsequent tracings (p.342).

Leung et al. (1993b) examined the issue of fine detail omission in their study of tracings and found that the symbols produced by this method of forgery generally ‘displayed less detail as compared with the corresponding simulations’ (p.415). One of the details that the volunteers were asked to trace was a tiny dot within a rectangle and, in confirmation of Ellen’s claim above, the researchers found that over 95% of the participants failed to reproduce this unobtrusive feature in their tracings. In support of the anecdotal explanations for such omissions, Leung et al. concluded that since the outline of the model writing ‘is usually masked by the paper on which the tracing is to be done’ this will cause ‘some minutiae’ to be lost in the subsequent tracing (p.415).

4.2.6 Incorrect Line Direction

Traced forgeries will often be ‘pictorially correct’ but will be produced with the ‘wrong movement’ or line direction (Levinson, 2002, p.49). In particular, it is to be expected that a tracing will fail to reproduce the correct line direction of any clockwise or anticlockwise loops displayed in the model writing. Leung et al. (1993b) have reported that 93% of the circles that their volunteers were asked to trace were copied using an incorrect line direction (p.415). Metzler (1981) has also reported that the cross-bar of the letter ‘t’ will frequently be traced in the wrong direction to that of the model writing and that stroke ends

will sometimes be found to curve in the opposite direction to those in the genuine writing (p.9).

4.2.7 Over Extension of Strokes

Hilton (1939) and Osborn (1929) have both noted a tendency for tracings to display stroke lengths that are inconsistent with the model writing. Osborn has remarked generally that ‘the traced lines of the copy [...] may go slightly beyond the extremities of the dim outlines which are being followed’ (Osborn, p.342); however, Hilton has noticed that it is the vertical strokes more specifically that can often be observed to continue further below the baseline than their corresponding strokes in the genuine writing. Hilton suggests that this is due to the position in which the forger must necessarily hold their pen in order to be able to execute the tracing, which makes it ‘difficult [for the forger] to see exactly where the stroke ends in the model signature and, as a result, [...] certain strokes fail to end at the proper point’ (p.591).

4.2.8 Inconsistent Alignment to the Printed Line

In an article that discusses a practical casework situation, Metzler (1981) highlights the characteristics that were used to identify two questioned signatures as traced forgeries. In reproducing the testimony she gave in court concerning these signatures, Metzler states that the alignment of some parts of the writing was inconsistent with the genuine signature and that in addition the overall alignment of both questioned signatures in relation to the printed line was incorrect (p.7). Metzler concludes that ‘[t]he unconscious placement of the

two questioned signatures farther to the left on or beyond the printed line than the known signatures is a highly significant point. In the known signatures the unconscious tendency is to move the signature to the right of the beginning of the printed line' (p.9).

Metzler does not suggest any reasons why these particular errors occurred in the forgeries she examined, but it may be conjectured that the forger gave no conscious thought to the overall positioning of the tracings during their execution and that the discrepancies found between the tracings and the genuine writing were due to a resurfacing of the forger's habitual manner of writing. However, Baker (1955) has observed that a displacement of letters in a tracing may be due to a slippage of the paper on which the tracing is made (p.258).

The importance of examining the baseline of a suspected tracing is, Harrison (1967) writes, 'all-important because it is remarkable how many [genuine] writers are consistent in the way in which they position their signatures relative to such markings' (p.114). Consequently, any significant departure from the genuine writer's customary habits should be regarded as suspicious.

4.2.9 Extraneous Marks

A common by-product of the carbon or tracing paper methods is that 'general smudges' can appear wherever the carbon or graphite covered paper has been in contact with the forged document. Harrison (1966) has observed that carbon smudges in particular leave 'a greasy line which cannot easily be erased when the inking-in has been completed' (p.383).

Consequently, the presence of smudges on a questioned document can be of ‘great evidential value [...]’ and ‘should arouse suspicion that a traced forgery might be present [...]’ (p.41). Harrison maintains that while there may be ‘acceptable explanations’ for the presence of pen, pencil or faint ink markings in a questioned signature, ‘there can be no excusing any traces of carbon paper markings which might be present’ (p.395).

4.2.10 Discrepancies of Size

In spite of the fact that a traced forgery is an attempt to copy faithfully the form and dimensions of a genuine writing, Baker (1955) has observed that some traced signatures differ from their model writing in that they expand or contract in size. This, he states, can ‘give the traced signature an unnatural appearance’ (p.258). Metzler (1981) also reports that individual letters can become smaller in a traced forgery. In her examination of two traced signatures she found a sudden diminishing of size of certain groups of consecutive letters, where in the genuine signatures these had been consistently sized (p.9).

There is, however, no empirical information with which to support these claims, although Leung et al. (1993b) have reported that discrepancies in height to width ratios can be observed in some traced forgeries. In an examination of the tracings of certain symbols that were chosen specifically to enable the researchers to record the ability of writers to reproduce height to width ratios, it was found that 37% of the writers increased or decreased ratios. A tendency to increase the ratio was found to be more common than a decrease (p.415).

4.2.11 Discrepancies of Slant

It is to be expected that the slant of a tracing will accurately reproduce that contained in the model writing it copies. Ordinarily, this will, indeed, be the case, states Osborn (1929), and questions of slant will usually 'have little or no significance in connection with a traced forgery inquiry'; however, in those places where the model writing is 'so lightly written' that it cannot 'be distinctly seen through the paper', it may happen that the slant will not be duplicated (p.146).

Significantly, Leung et al. (1993b) have found that '[t]he tracing of slant and tilt of the upper-case letters 'I', 'E', and 'T' 'appeared to be more difficult' for the volunteers to achieve in comparison with the tracing of other target features. They report that tracings of these letters 'were only marginally better than the corresponding results for the [freehand] simulation of the same alphabets'. Leung et al. conclude that because the slant and tilt of these letters was 'small in magnitude', their angles of inclination in relation to the imaginary line of writing became 'less conspicuous features' which resulted in 'poor accuracy' being achieved in the tracings (p.415).

4.2.12 Incorporation of the Forger's Individual Characteristics

Zecca (1993) has stated that a traced forgery can disguise the natural hand of the forger so that it is 'impossible' to determine the authorship of tracing, but that 'occasionally' a forger will inadvertently 'incorporate his/her own writing habit somewhere along the writing line' (p.32). In the case of a tracing made with carbon paper, Dines (1998) maintains that an

examination of the characteristics of the suspected forger 'will usually' confirm his or her identity since 'a few of his own characteristics' will appear in the subsequent tracing (p.270). However, Dines gives no justification for this conviction and no other writer appears to make a similar point. On the contrary, Conway (1959) argues that it is 'unreasonable and incompatible with experiment and experience to expect to find one's writing characteristics, and in sufficient number and kind to identify him, in a traced drawing of the signature of another' (p.22). Ellen (1997) agrees unequivocally: traced writings, he states, 'contain no evidence of their writer' (p.40).

PART III

The Research Design

5 THE RESEARCH DESIGN

Two distinct surveys relating to disguised handwriting and traced forgery were designed to address the question of whether forensic handwriting examination can be put on a more empirical footing to increase the probative value of its evidence. More specifically, they sought to elicit reliable data that could indicate whether handwritten scripts that are known to be deviant share common characteristics, and/or whether specific categories of deviant writing contain distinctive shared features that set them apart from other types. The surveys have endeavoured to establish the extent to which it is possible to obtain quantitative evidence with which to establish a systematic and comprehensive classification of the distinctive inherent features of deviant handwriting.

5.1 Research Methodology

Numerical data was collected by the administration of two controlled experimental tests, the results of which are reported as a set of statistical summaries. The statistical summaries form the basis of a comprehensive taxonomy of the characteristics of disguised handwriting and the characteristics of traced forgery.

Self-administered questionnaires were used to assist in the interpretation of the sample data obtained and an evaluation of the findings was made in light of the responses given by the

participants in support of their efforts at producing their samples of disguised and traced handwriting.

5.2 Research Method – Disguised and Traced Surveys

In order to gather and evaluate a body of controlled data, a number of individuals were required to produce samples of disguised handwriting and traced signatures to compare with a control body of natural handwriting. Sixty respondents, both male and female, took part and were randomly assigned to one of two experimental groups. The first group participated in a disguised handwriting survey, which was subdivided into disguised handwriting and disguised signatures, and the second group was involved in the survey to examine traced forgery.

The subjects were aged between 18 and 55 since writers within this age range tend to display individual handwriting characteristics that are sufficiently fixed, and those writers at the higher end of the scale were not yet of an age where infirmity was likely which would affect the production and appearance of their handwriting.^{cxxv} Furthermore, participants with significant health related issues that could have potentially affected their handwriting were excluded. This information was gathered firstly from an initial participant screening process (described in section 5.3.1), and was reconfirmed by the information that was provided by the volunteers in the self-administered questionnaires

The sample was collected only from those subjects who were taught to write in the British educational system. This was for two main reasons. Firstly, it was assumed that the

majority of individuals who were taught handwriting in the same educational system would react, for the most part, identically under the same experimental conditions; and secondly, it was to eliminate any potential errors that might have resulted from an erroneous conclusion that certain unusual writing features were idiosyncratic to a particular writer when, in fact, they derived from the learned system of handwriting. This is not to suggest that the findings of this research cannot be applied to writing in other languages; indeed, it is likely that the methods of disguise and traced handwriting will be the same for writers who have learned to write in most alphabetic language systems. Consequently, it is anticipated that the results generated by this study will have a general application to those writings produced by individuals who have learned other systems.

5.3 Target Population Defined

The quality of the data generated by each survey was paramount, so it was essential that the sample was designed to reflect the overall UK criminal population that engages in forgery and fraud. To ensure that the sample obtained was as representative as possible in terms of the size and available demographic data of the larger population, and to avoid unintended bias, stratified random sampling was employed using statistical information contained in two annual bulletins published by the Ministry of Justice: Sentencing Statistics: England and Wales 2008 (2010) and Statistics on Race and the Criminal Justice System 2007/8 (2009).

The proportion of the criminal population that is specifically involved in crimes of forgery and fraud can be identified from these two reports, and the data they supply were used to

calculate a practicable sample size^{cxvii} and distribution for this study. The Sentencing Statistics bulletin provides data of the total number of offenders sentenced for fraud and forgery offences and categorizes it according to gender distribution and age groups; The Race and Criminal Justice System Report provides similar data, but classifies it by ethnic appearance, offence group and police force area.

A target geographical area was selected at random from the categories provided by the annual bulletins. By selecting individuals proportionally using data relating to the target geographical area, the demographic trends of the overall criminal population, including its size, gender, age and ethnicity distributions, could be better reflected in the composition of the test population (see Appendix 1).

5.3.1 Identifying the Participants

Based on the above sampling categories, an enumeration process (door-to-door screening) was used to identify suitable candidates for this study. One hundred and sixty individuals were subsequently identified and a random sample selection used to create a final list of eighty people who were invited by letter to participate in the study.

The survey response rate was very good^{cxviii} since 75% of those invited agreed to take part in the study. A high percentage return rate was important since the extent of nonresponse can markedly affect the validity of the test population and therefore the validity of the data generated. A high number of non-respondents would have considerably increased the likelihood of a final test group that was unrepresentative of the original target population,

and this would ultimately have created significant result bias (Mangione, 1995, p.61; Bethlehem, 2009, p.4). However, the survey response was gratifyingly high and the completion rate at 100% was excellent.^{cxxviii}

Of the sixty individuals that eventually took part in the study, thirty produced one hundred and fifty samples of disguised writing and thirty produced 56 traced signature samples.^{cxxix}

5.4 Controlling Factors to Minimise Results Bias

In an experiment of this type there is always a risk that factors may occur to adversely affect the research results to the extent that these could not be replicated under actual criminal conditions. A lack of impetus, such as the threat of prosecution, time constraints and tedium may all influence the way in which the participants carry out the tasks requested of them. However, it was expected that since the subjects were all volunteers, they would be reasonably well motivated. Nevertheless, to help control any other potential issues that might contribute to inaccurate test results, the following interventions were made:

- To reduce a lack of impetus on the part of the subjects, the survey tests were clearly written and easy to complete with no time constraints imposed on the actual production of the disguises or tracings. This was to prevent the task from becoming too onerous to the participant.

- A deadline was given to the participants for the return their work in order that the tests were completed in a reasonable time; it was hoped that the implementation of a time limit for returning the test would prevent too relaxed an attitude on the part of the subjects.
- A stamped addressed envelope was provided to make it easy for the subjects to return their tests and to prevent any costs being incurred by the subjects and too prevent non-response.
- Telephone and email follow-ups were made to the subjects to determine motivation, and to clarify any questions that arose about their writing samples or to clarify any responses they gave in their questionnaires.

5.5 Disguise Survey

In order to explore the possibility of obtaining reliable data relating to the distinctive features of disguised writing, a survey was designed to test the following hypotheses:

- Handwriting that is known to have been deliberately altered in an attempt to camouflage the writer's identity will contain characteristic features that are shared with other forms of deviant writing and which can be used to categorize it as such.

- Handwriting that is deliberately disguised will exhibit characteristic features that will expose it as disguised and set it apart from other forms of deviant writing.
- Handwriting that has been deliberately disguised will contain elements that are unique to the writer which can be used to identify them.

5.5.1 Procedure

The volunteers were first asked to produce samples of their natural handwriting to serve as the control sample. Each sample was made on a pre-printed form and included the following: 1) a paragraph of natural cursive writing, 2) a paragraph of block capitals, 3) a natural signature and 4) written numerals.

The participants were then asked to fill in the form a second time but in a handwriting that was disguised in such a way that the writing could not be attributed to them. The control writings (or standards) were examined and any individual variations were noted, while the specimen disguised writing and signatures were examined to establish if common characteristics were present and to determine whether certain methods or combinations of methods were preferred over others to make the disguises. The disguised writing was also compared with the control writing to determine the extent to which the disguises were successful by means of establishing whether or not it was possible to identify the writers.

5.5.2 Information Pack

To ensure consistency, as far as possible, in the conditions under which the subjects produced their disguises, each respondent was provided with an information pack containing the following:

5.5.2.1 Explanatory Letter to Subjects

To ensure a reasonable response rate, it was considered important that the respondents were made aware of the significance of the test. For this reason a letter was sent to each respondent which explained the test in simple terms whilst placing it within an appropriate context (see Appendix III). The letter provided brief instructions on how the test should be performed and a deadline for its return.

5.5.2.2 General Questionnaire

The General Questionnaire was a brief, confidential form by which personal information about the volunteers was collected; questions about age, handedness, education and health (see Appendix X) were included.

5.5.2.3 Pre-Printed Forms: Collecting Natural and Disguised Samples

Pre-printed forms were considered the most appropriate method for capturing the volunteers' natural and disguised handwriting. Forms 1a and 1b (see Appendices VII and VIII) were used for collecting the subjects' typical day to day handwriting. Each person

was asked to write their name in full, to sign their signature, to provide a date and time of writing and to write an address in lower-case letters and again in block capitals. They were also asked to write out an extended passage of writing twice, first in lower-case letters and again using block capitals only.

Form 2 was used to collect the subjects' disguised writing samples. The testing elements included the disguising of an address, date, time, each subject's name and signature, and the disguising of a piece of extended text (see Appendix V).

5.5.2.4 Disguised Handwriting Questionnaire

The questionnaire was used to collect the participants' assessments of how successful they perceived their disguises to be. Their responses were used to assess the following: the qualitative generalizations made in the literature that relate to whether or not writers are able to perceive errors in their disguises, to identify any difficulties the volunteers experienced during the test, and to determine whether the subjects were aware of the more subtle characteristics of both their own and other people's handwriting.

5.5.2.5 Additional Materials

A stamped addressed envelope was provided for the subjects to return their surveys, and a ball point pen was included for the subjects to use during the test.

5.6 Traced Forgery Survey

In order to explore the possibility of obtaining reliable data relating to the distinctive features of traced forgery, a survey was designed to test the following hypotheses:

- Handwriting that is known to have been traced will contain characteristic features that are shared with other forms of deviant writing that can be used to categorize the writing as such.
- When handwriting is traced, it will exhibit characteristic features that will expose it as traced and set it apart from other forms of deviant writing.
- A hand traced forgery will not contain elements that are unique to the writer which can be used to identify them.

5.6.1 Procedure

Volunteers were asked to provide a sample of their natural, cursive handwriting to provide a control sample by which the traced forgeries could be compared. Since it is generally agreed that traced forgery typically involves signatures, the subjects were asked to trace a given signature twice using any method they wished. The control samples were then examined and individual variations noted. The traced forgeries were studied to establish if shared characteristics were present and to determine the preferred tracing methods that

were used to produce them. The traced specimens were then compared with the control writing to determine the extent to which individual attempts at traced forgery were effective and to determine if there was sufficient individuality in the tracings to enable their authors to be identified.

5.6.2 Information Pack

To duplicate, as far as possible, the conditions under which the subjects produced their tracings, each respondent was provided with an information pack containing the following:

5.6.2.1 Explanatory Letter

In an attempt to ensure a reasonable response rate, it was considered important that the respondents should be aware of the significance of the test. For this reason a letter was sent to each respondent which explained the test in simple terms whilst placing it within an appropriate context.

5.6.2.2 General Questionnaire

The General Questionnaire was a brief, confidential form by which personal information about the volunteers was collected. This included questions about age, handedness, education and health.

5.6.2.3 Pre-Printed Forms: Collecting Natural and Traced Samples

In the same way as the disguised survey, pre-printed forms were considered the most appropriate method for capturing the participants' natural and traced handwriting. Two forms were used for the collection of normal day to day handwriting. Each person was asked to write their name out in full, to sign their signature, to provide a date and time of writing, and to write an address in lower-case letters and again in block capitals. They were also asked to write out an extended passage of writing twice, first in lower-case letters and again using block capitals only.

Another form was used to collect the subjects' traced writing samples. The volunteers were asked to trace a given model signature twice: once on a pre-printed baseline and once in a pre-printed text box. The subjects were asked to identify the traced signature that they believed was their best forgery.

5.6.2.4 Model Signature

The genuine signature that served as a model for the participants to trace was one that has been used previously in an examination of the characteristics of freehand simulations (Lafone, 2005). It was considered important to use the same signature in both studies so that common points of reference could be examined. This allowed for more accurate comparisons to be made between the different forgery types so that ultimately more meaningful data would be produced.

The model signature has been described in Lafone (2005, p.55), but as it forms an integral part of this current research, it is felt important to briefly detail again its main characteristic features.

The signature is in the name of K. Pritchard-Jones and is written fluently by a right-handed adult. The signature is relatively long and has been executed at medium speed. Standard letter forms can be observed in the signature as well as some that are characteristic to the writer. The writing contains varied pressure and shading with light upstrokes and heavier down strokes. Stroke endings are generally tapered except for the beginning and end of the staff of the capital letter 'K', the down stroke that forms the top arm of the capital letter 'K' and the end of the final stroke of the signature, all of which are blunted. The signature contains some very faint hairline strokes and the baseline of the writing can be seen to undulate moderately above the pre-printed line.

5.6.2.5 Traced Handwriting Questionnaire

A questionnaire was used to collect the subjects' assessments of how successful they perceived their tracings to be. The subjects' responses were used to: a) examine the qualitative generalizations made in the literature that relate to whether or not writers are able to perceive errors in their traced forgeries, b) to identify any difficulties the volunteers experienced when producing their tracings, and c) to determine whether the subjects were aware of the more subtle characteristics of both their own and other peoples' handwriting.

5.6.2.6 Additional Materials

A stamped addressed envelope was provided for the subjects to return their surveys, and a ball point pen was included for the subjects to use during the test.

5.7 Qualitative and Quantitative Analysis

A distinction has previously been made between those features of handwriting that are an assessment of its movement, rhythm and form (qualitative), and those elements that can be measured physically (quantitative), and the terms qualitative and quantitative have been used to distinguish between these two main by interrelated areas of handwriting examination (Lafone, 2005, p.62-64).

5.7.1 Qualitative Analysis

The quality of a person's writing is dependent upon a number of factors, including hand position, pen hold, pen position, the speed at which the writing is made, the legibility of the writing, the complexity of letter forms and the pattern of writing learned, and these will all be affected by the physiological and neurophysiological constitution of the writer (Lafone, 2005, p.62; Morris, 2000, p.67). The construction of individual letters, line direction, pen pressure and shading, together with such features as blunt ends, acute angles, hesitation marks, pen-lift, overwriting, retouching and tremor, are all included under the heading of qualitative features.

5.7.2 Quantitative Analysis

A system of handwriting measurement and categorization was developed recently for the examination of freehand simulated signatures (Lafone, 2005). The methodology is based on a consolidation and augmentation of observations and applications that have been described in the literature and has produced results that suggest that the dimensions of handwriting can be recorded with 'reasonable accuracy and consistency' (p.66).

To ensure that the procedures for measuring all forms of deviant writing were consistent, and that the interpretation of results was compatible, the procedures that were used for judging the dimensions of freehand simulations are also those that have been employed in this current research.

Drawing upon the principles and procedures of this system of measurement has distinct advantages: its operations have already been defined and experimentally administered and it has been found to produce accurate and reliable data. It is, of course, true that the measurements were originally applied to the examination of signatures, but the principles can also be used to obtain the dimensions of extended handwriting 'since it is generally accepted that the techniques for comparison are fundamentally the same for the two' (Lafone, 2005, p.66).

The definitions of the linear and angular categories of measurement below are based on those that were included in Lafone (2005). Consequently, a degree of repetition will be noticed; but because this system of measurement is central to this current study, it is

deemed necessary to reiterate the classifications here as they apply to disguised and traced writing.

5.7.2.1 Linear and Angular Measurements

An examination of the naturally made writing samples was conducted to determine the participants' characteristic writing patterns and to assess their range of natural variation in regard to the size, proportion and slant of their writing. It was essential that this information was established for all the writers in each participant group so that meaningful comparisons could be made with their deviant writing to test the validity of those claims that suggest that a writer will invariably revert to habitual ways of writing during the making of a disguised or traced writing.

The traced survey also included measurement of the model signature, so as to isolate any quantitative features in the tracings that could not be attributed to the genuine writing or to the individual characteristics of the writer.

As was discussed in section 5.6.2.4, the model signature that has been used for the study of traced writing is that which has been used in an examination of simulated signatures (Lafone, 2005, pp.73-80). To avoid duplication, the comprehensive description of the measurement of this signature is reproduced in Appendix II.

It has been claimed that the measurement of writing is 'unrealistic in ordinary practice' (Baxter, 1973) since it is said to be dependent upon 'such exhaustively detailed

examination' (p.183).^{cxix} Certainly, the constraints of an examiner working alone within a limited time scale made it impracticable to measure every single letter, word and spacing within the samples of natural writing; accordingly, key target features and words were chosen to be measured to ensure that the procedures applied to one sample could be equally applied to them all. Target elements included: common letter combinations, e.g. 'oo,' 'll' and 'tt'; the date, times, names, signatures and common words, including articles and conjunctions, and the individual characteristics of each writer was recorded.

As was acknowledged in the examination of simulations, a degree of subjectivity remains inherent in the process of measuring handwriting, since 'two people measuring most aspects of a signature [...] may differ, for example, in their judgement as to when a joined letter starts and stops' (Lafone, 2005, p.67). Because of this, some imprecision may be detected, but the measurements taken for this study and for the examination of simulations were repeated twelve months after they had first been completed and in all cases produced consistent results.

5.7.2.1.1 *Linear Measurements*

The linear dimensions of writing are those horizontal, vertical and diagonal measurements that can be made with a single linear rule. The following measurements were made:

5.7.2.1.1.1 Overall Horizontal Measurement

A measurement to appraise horizontal size is taken between carefully defined features at the extremities of a word or signature. A horizontal line is drawn from the base or lowest point of the stroke extending furthest to the left hand side of the writing to the base of the stroke extending furthest to the right hand side of writing.

5.7.2.1.1.2 Mid-Zone Height

A calculation is made to discover the average size of the *mid-zone* or *linear* letters in a word or signature, i.e. those lower-case letters having no components extending above or below the x-height, such as the lower-case letters 'a', 'c', 'e', 'o', 's'.

To obtain the vertical dimension of each letter, a perpendicular line was drawn from its highest vertical point, or apex, to its lowest vertical point, or base. This procedure was the same for both vertical and slanted letters.

A mean calculation of the vertical dimensions was made and the result represents the mid-zone height.

5.7.2.1.2 *Relative Spacing*

This is concerned with a) inter-word spacing, b) intra-word spacing and c) the average vertical height or depth of the signature above or below the baseline.

5.7.2.1.2.1 **Inter-Word Spacing**

The lateral spacing between words or names.

Since a signature is a stylized shortened version of a person's name, 'word' is defined as being any name that appears in its entirety within the signature, or any capital letter that stands in place of a full name and which precedes the surname.

5.7.2.1.2.2 **Intra-Word Spacing:**

The lateral spacing within words.

5.7.2.1.2.3 **Determining Relative Spacing**

A horizontal line is drawn between consecutive letters in the following ways:

Where letters possess staffs (e.g. 'K'-'P' or 'P'-'r') a horizontal line is drawn between their staffs at the baseline. Where letters were curved, hooked, or were in some way constructed differently at their base, a horizontal line was drawn between the corresponding mid-points on each letter; mid-point is defined as being midway between the highest and lowest points of the stroke.

It is unreliable to measure between such letters at the baseline since it is difficult to judge, with any consistency, where the points of measurement should be made.

When measuring the space between a letter possessing a vertical staff and a curved letter or vice versa, such as ‘t’-‘c’, a horizontal line is drawn between the mid-point on the vertical staff and the mid-point on the back of the curved letter.

5.7.2.1.3 *Relative height*

The relative relationships of height between and within individual letters. A perpendicular line is drawn from the top or apex of each capital letter to its base or lowest part of the stroke, which may not necessarily coincide with the baseline of the writing.

5.7.2.1.3.1 **Ratio of Letter Height to Width**

The relative relationship between the vertical measurement of a letter (its height) and its horizontal measurement (its width).

The ratio of each character is found by dividing its height by its width. A vertical line drawn from the top or highest point of each character to its lowest

point or base determines its height. The base of a loop is defined as being the point at which its ascending and descending strokes intersect.

The width of each character is found by drawing a horizontal line from the point furthest to the left hand side of each letter's staff (or where there is no staff, the furthest point left of the letter's axis) to the point furthest to the right hand side. The measurement includes the body of the letter only and excludes any connecting strokes.

A person's handwriting rarely follows the copybook norm consistently, and it is often difficult to judge where the body of a letter ends and a connecting stroke begins; a certain amount of subjectivity, and so imprecision, is, therefore, involved in making these decisions. Generally speaking, however, the width or body of a letter is taken to be at the end or lowest point of the final stroke at the point where the stroke changes direction to create a connector. In the absence of a change of direction in the stroke, the letter's body is judged in relation to other strokes that formed the letter (see Appendix II).

The height of each letter was not measured at the angle at which the letter was written as some examiners propose (Schroeder, 1974, p.107) because such a method depends upon the absolute accuracy of the angle found (see Appendix II).

5.7.2.1.4 *Interior Dimensions of Oval and Looped Formations*

Each oval is measured by drawing a line through its furthest two points to form an axis. The axis line is then measured inside the oval to obtain its internal size.

5.7.2.2 **Angular Dimensions**

5.7.2.2.1 *Relative Slant*

Relative slant concerns the relative relationships of slant of the component strokes within letters and the relationships of slant between individual letters and connecting strokes.

Slope is defined as being ‘the angle or inclination of the axes of letters relative to the perpendicular to the baseline of the writing’ (Huber and Headrick, 1999, p.107). This definition makes it easily understood that as a writing leans further to the right (forwards) or to the left (backwards), the angle or slope of the writing increases.

To determine the angle of slant of the staff of a letter, a 90-degree line is drawn beside the staff starting at the baseline. A second line is then drawn along the staff. The angle between these two lines represents the staff’s angle of slant.

Component parts are measured by drawing a 90-degree line from the point at which the component part and the staff intersect. A second line is then drawn along the component part from the intersection to the top or bottom of the stroke depending if the stroke rises or falls. The angle between these two lines represents the angle of slant.

When the stroke that forms the staff or component part of the letter is found to curve, an axis line is constructed along the stroke so that it passes through the maximum number of points on the stroke as possible. A 90-degree line is then drawn beside the axis and the angle between the two lines will represent the stroke's angle of slant.

5.7.2.2.1.1 Measuring the Slant of Circular Letters or Loops.

A perpendicular line is drawn beside each letter. A second line is then drawn through the furthest two points on the loop or ellipse to form the letter's axis. The angle between the perpendicular line and the axis line represents the angle of slant.

5.7.2.2.1.2 Measuring the Elevation of Connecting Strokes

A 90-degree line is drawn beside each connecting stroke beginning at the baseline. A second line is then drawn along the connecting stroke. The angle between these two lines represents the elevation or angle of the connecting stroke.

Where a connecting stroke curves, an axis line is constructed so that it passes through as many points on the stroke as practicable. The angle between the 90-degree line and the axis line is taken as the angle of the connecting stroke.

Where a word or signature had no discernible lower-case letters but merely an undulating line, the angle of rise was measured each time the line rose in a step-like formation.

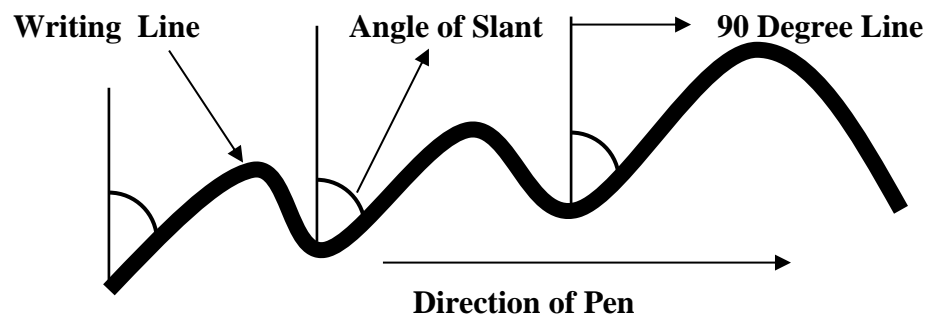


Figure 1: Measuring the Elevation of Undulating Curves.^{cxxxii}

A 90-degree vertical line is drawn beside each rise in the stroke. A second line is then drawn along the stroke itself. The angle between these two lines represents the elevation or angle.

5.7.3 Photographing the Writing Samples

Digital images of the natural and deviant writing samples were made to ensure that the writing was measured with the greatest consistency and accuracy. The following procedure was followed:

1. A Veho VMS-001 USB microscope was used to photograph the writing samples and the pictures were stored in JPEG format.
2. The photographs were imported to CorelDraw™, a computer graphics application, version 6.00.176. Each sample of writing had been photographed with a standard metric rule so that the images could be rescaled within CorelDraw™ to correspond exactly with the size of the original writing. Linear and angular dimension lines were created using the appropriate dimension tools within CorelDraw™.

5.7.4 The Database

A unique database was developed to capture and analyse the vast number of results that were generated by this research. Sixty participants created 420 disguised, traced and natural handwriting samples, which involved the input of 467,460 separate data points. The results were reported out into Microsoft Excel. A detailed description of the database can be found in Appendix XI.

PART IV

Data Analysis

6 DATA ANALYSIS

6.1 Methods of Disguise

Thirteen modes of disguise were identified in this study and these were employed by the participants in combination or separately. Without exception, all the methods observed reflect those that have already been reported in previous studies and supports the view generally held in the experiential and theoretical literature that despite the myriad ways in which a writing can be disguised, those wishing to camouflage their writing will tend to choose from only a limited range of techniques.

The highest number of methods employed by an individual in their sample of extended text was found to be seven, whilst the highest number of methods used in a single disguised signature was four. Across both sample groups, the lowest number of methods used for any single disguise was found to be one. The average number of disguise methods used per sample was similar across both sample groups, being 3 for extended disguise and 2 for the disguise of signatures.

The data revealed that the features of handwriting most targeted for alteration were those primary elements that are said in the literature to influence the overall appearance of handwriting, such as its slant, letter formation, letter size and the care with which it was

made.^{cxxxii} However, this was not an unexpected finding as the writers generally sought to camouflage the overall look of their scripts and signatures.

It was, however, the alteration of slant that was found to be the most favoured technique for the disguise of signatures and for extended writing, since over half the participants chose to use this method to make deliberate alterations to their handwriting, and this finding agrees with the results reported by Harris (1953), Kropinak (1965), Alford (1970), McKasson and Lesk (1973), and Konstantinidis (1987).

It was notable that there were a few individuals who made efforts to eliminate the primary elements of their writing from their disguises and, although they may not always have been successful in their attempts to do so, their endeavours reveal that some individuals will have a greater knowledge of their handwriting than others. Consequently, the handwriting examiner should not assume that disguisers will always camouflage the most obvious features of their handwriting but should be aware of what Harris (1953) has described as ‘the great capabilities’ of the few (Harris, 1953, p.687).

The disguise tactics that were employed by the participants during this survey are discussed in more detail in the following sections.

6.1.1 Writing Slant Alteration

57%^{cxxxiii} of the participants were observed to have made a deliberate change to the slope of their natural handwriting as a disguise tactic during the extended passages of writing.

Significantly, an equal number of participants also used this method to disguise their signatures.

That over half the writers chose to modify their habitual writing slant to alter the appearance of their writing supports the view generally held in the literature that this is a popular method of disguise. The findings from this experiment are consistent with the empirical work of Harris (1953), Kropinak (1965), McKasson and Lesk (1973) and Konstantinidis (1987), in that they reveal an alteration to slant to be the disguise method most frequently employed by writers, both singly and in combination with other disguises.

6.1.1.1 Direction of Slant Preferred by the Disguiser

Several claims have been made that those who deliberately change the slant of their writing will tend to alter it in a leftward direction and this is generally supported by the results from this study. The strong findings reported by Downey (1917), Kropinak (1965), Alford (1970), Regent (1979), Jamieson (1983) and Konstantinidis (1987) were not replicated by this research but the data closely agrees with that found by Keckler (1997) and Harris (1953). A tendency (56%) was found for disguisers to alter their habitual slant from a rightward to a leftward direction and of these, over half (53%) produced an extreme reversal of their habitual forward slant.

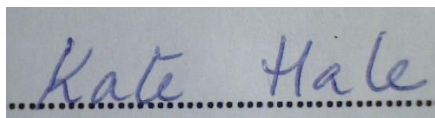


Figure 2: Natural Forward Slant.

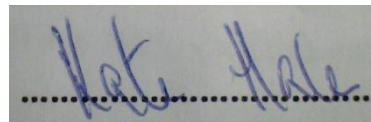


Figure 3: Disguised Backward Slant.

6.1.2 Numeral Alteration

Several numerals were incorporated in the text that the participants copied in a disguised hand. This was done in order to test whether ordinary writers were able to recognize the individuality of their handwritten figures and appreciate the importance of disguising them. The results showed that 40% of the participants did indeed make attempts to modify the form of some or all of their numbers. Although this figure is somewhat higher than that found by Keckler (1997), it generally accords with the conclusion expressed in the observational literature that the majority of individuals will tend to leave their numerals unaltered during disguise.

Of those who did alter their numbers, the majority (58%) preferred to make embellishments to them with the addition of loops and curls. Other writers (18%) substituted the conventional British number 7 with a European version which adds a horizontal line across the down stroke. Less often, writers were observed to have produced a printed form of their numbers, increased their size or written them in a more rounded copy book version (8% in each case).

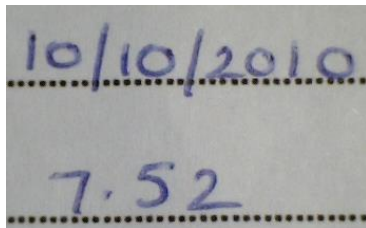


Figure 4: Natural Numerals.

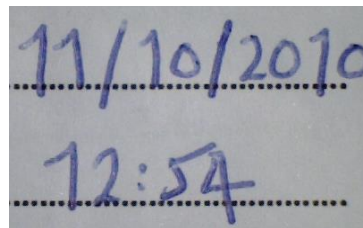


Figure 5: Embellished Disguised Numerals.

6.1.3 Letter Form Alteration

27% of the participants overall stated that they attempted deliberate changes to the letter shape or design of their letters as a method of disguising their handwriting. That this was not an overly popular method of disguise was surprising as it is generally agreed in the literature that the way in which letters are formed is one of the major contributing factors to the individuality of handwriting in terms of its structure and its appearance. Consequently, this feature would be more susceptible of notice and, therefore, of alteration by the disguiser.

Contrary to the empirical findings discussed in section 1.4.2.1, this study found no evidence to suggest that a deliberate alteration to a text's capital letters will occur any more frequently than an alteration to its lower-case letters. 80% of those participants who were observed to have modified the formation of their letters in their disguise of extended text and in the disguise of their signatures were found to have targeted both lower-case and upper-case letters equally. These findings challenge the suppositions made by Downey (1917) and Keckler (1997) that since capitals are more conspicuous than lower-case letters and are made with a higher degree of consciousness, this makes their alteration more easily achieved and, by implication, more likely to occur. Nevertheless, in agreement with observations made by Keckler (1997) and Harrison (1962), this study did find that on those occasions when the form of a capital letter was modified, a slight tendency existed for it to be changed from a cursive to a printed form more frequently (12%) than vice versa (8%).

The conviction that conspicuous letters are more likely to be targeted for alteration during disguise was also contradicted by the data relating to the signature samples. Highly visible

letters, such as those habitually made in an overly stylized or conspicuously plain design, were found to have been altered by the participants less frequently than other letters in the script. Indeed, only 20% of those who were observed to have deliberately modified the form of their letters in their signatures attempted changes to all of their characteristically conspicuous letters. This finding was quite unexpected since a signature is typically distinguished by its stylized letter forms and it had been thought that the form of the majority of these visibly prominent letters would be modified.

Hayes (2006) has claimed that when letter forms are altered for the purposes of disguise, '[i]t is most common to change the first and/or last letters of words which will cause the most immediately noticeable effect' (Hayes, 2006, p.165). This was not found to be true in the samples of disguised extended text where no distinctive or consistent patterns emerged to suggest that the position in which a letter is written is in anyway related to the likelihood of its alteration. However, such a relationship was identified in the samples of disguised signatures where the alteration of form as a disguise method had been observed. A large majority (60%) of these signatures exhibited deliberate alterations to the form of the first letter while second and subsequent capitals were overlooked. Moreover, the simultaneous alteration of the first and last letter of a signature was much rarer as only one individual was observed to have made such an attempt.

Modifications to both upper and lower-case letters were generally found to be limited to their embellishment and/or simplification, with few participants (22% overall) attempting to create whole new letter forms. No pattern emerged in either sample group, however, as to whether it was more likely for upper-case letters or lower-case letters to be targeted for such changes. Typically, letters were enhanced or made plainer by the addition or removal

of serifs, loops, and/or curls,^{cxxxiv} but no writer was found to have produced written forms in a grotesque manner.

Embellishment was preferred over simplification in the disguise of extended text since a high majority of the subjects (80%) were observed to have produced more elaborate letter forms in their disguised scripts than were found in their control writings. This finding becomes more significant when it is considered that an additional 10% of writers embellished their plainer letters whilst simultaneously combining this disguise with the simplification of some of their more habitually elaborate characters. Of those who were observed to have altered some or all of the letter forms in their disguised signatures, no substantial differences were found between those who made their letters more elaborately, those who made them more plainly, or those who preferred to substitute entirely new letter forms since equivalent results were found for each (33%). What was considered noteworthy, however, and was observed in both the extended writing and signature samples, was that where a person habitually wrote a plain letter, this would tend to be substituted with a more elaborate form in their disguised writing. Similarly, where the writer normally produced an elaborate letter in their usual writing, this would be altered to a plainer form in their disguise.

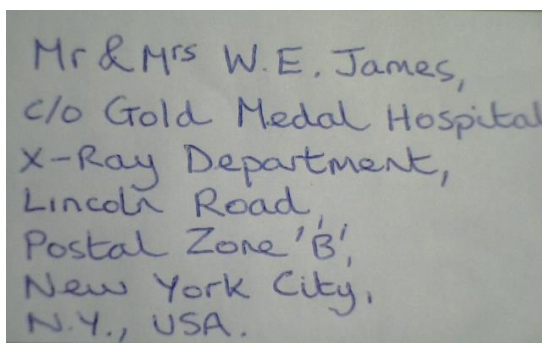


Figure 6: Naturally Made Plain Letters

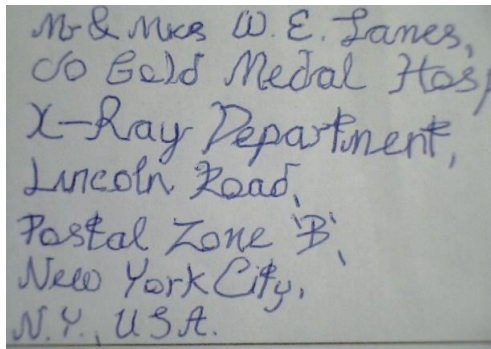


Figure 7: Embellished Disguised Letters.

No evidence was found which could substantiate the claims made by Alford (1970) and Herkt (1986) that certain lower-case letters would be more frequently targeted for alteration than any other, or which could support the statement made by Alford that the frequency of change to the lower-case letter 't' would increase when it appeared as the last letter of a word.

In the light of the fact that the majority of form alteration involved embellishment or simplification, it is to be expected that disguisers will tend to neglect the more subtle features of structure and fail to modify these. The results suggest that the ordinary writer simply does not possess an awareness of their own handwriting that is sufficient or comprehensive enough for them to understand the myriad ways in which they habitually construct letters and words. Without such knowledge, the writer's ability to make complex and fundamental changes to the formation of their script will be more or less unachievable, leaving them no recourse but to undertake superficial modification, a tactic that current results indicate is one to which the disguiser will most often resort.

6.1.4 Upper and Lower Extender Modification

Overall, just over one quarter of the respondents attempted to alter their usual method of forming the upper and/or lower extension strokes of their writing. Alterations to the ascenders were more frequently observed in the samples of disguised extended writing (37%) than in the samples of signature disguise (13%). In both sample groups it seemed that the ascenders were more visually prominent to the writers since these were targeted for alteration a little more frequently than the descender strokes. In the samples of extended writing, 58% of the writers chose to alter the ascenders, while 42% altered the descenders. In the disguised signature samples 67% were observed to have attempted alterations to their ascenders with 33% of these altering the descenders. These findings strongly support those reported by Herkt (1986) but run counter to those made by Downey (1917), Alford (1970) and Keckler (1997).

In every sample examined, there were only two methods observed by which the subjects altered their ascenders or descenders: looped strokes were either added or removed, although it was more usual for looped strokes to become plain (63%) than vice versa (37%).



Figure 8: Looped Strokes are Added to the Ascender Strokes as a Disguise.



Figure 9: Looped Ascender Strokes do not Appear in the Writer's Natural Hand..

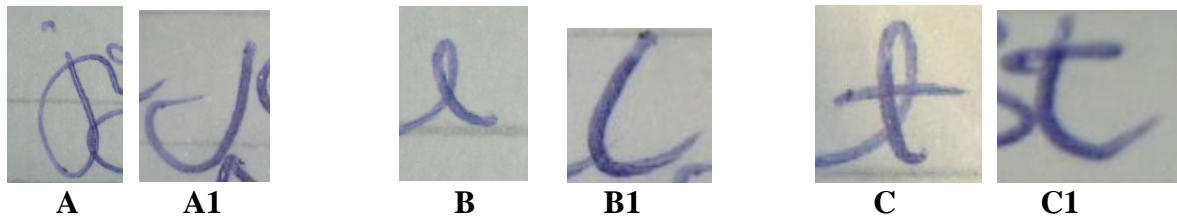


Figure 10: Natural Looped Descenders/Ascenders (A, B, C) become plain in disguise (A1, B1, C1).

6.1.5 Writing Size Alteration

A deliberate modification to the overall size of the writing was employed as a disguise method by 23% of the volunteers, and the frequency with which this disguise was used by each participant group was found to be the same. Although this disguise method was, therefore, a reasonably common way for people to disguise their handwriting in this study, it was not *the* most popular technique employed, a finding that differed from that made by Alford (1970), Leung et al. (1988) and Keckler (1997).

As was discussed in section 1.4.3, there is little agreement in the literature as to whether writers are more likely to increase or decrease the size of the writing in order to disguise it, although a general tendency for the writing to be increased in size was reported in the empirical studies. An examination of the samples of disguised extended text and signatures in this study found no overall difference between the frequencies of increased size and decreased size. However, marked differences were found between the frequencies when the two sample groups were examined independently of each other. In accord with the findings made by Downey (1917) and by Herkt (1986), the results revealed that of those who deliberately altered the natural size of their extended text, most (71%) chose to increase it;

conversely, the majority (57%) of those who deliberately modified the size of their signature as a disguise method chose to make it smaller.

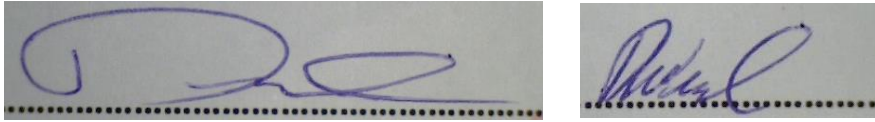


Figure 11: A large Authentic Signature Becomes Smaller in Disguise.

6.1.6 Writing Speed Alteration

Across both sample groups, 20% of the participants attempted to alter their habitual writing speed as a way of altering the appearance of their writing, a proportion that was consistent across both sample groups.

Section 1.4.11 showed that there is no compelling empirical evidence to validate whether writers will more commonly increase or decrease their writing velocity when manipulating writing speed and, indeed, the results from this study found that there was no tendency either way: 50% chose to increase their habitual speed while 50% decreased it. However, it was observed that all the participants who adopted this method of disguise simply reversed their usual speed of writing and that those who habitually wrote slowly always increased their writing speed, whereas those who naturally wrote rapidly always reduced their writing speed during disguise.

6.1.7 Handprinting

It is generally agreed upon in the literature that handprinting is one of the most common means by which individuals disguise their handwriting. In particular, it has been reported that the most predominant modes of handprinting disguise are block lettering and copy book writing (Osborn, 1929; Harrison, 1966; Mendelsohn, 1976; Robertson, 1991; Meuhlberger, 1998). Nonetheless, handprinting as a disguise method in this current study was not overly popular as only 17% of the participants chose to modify their handwriting in this way.

Moreover, the most popular methods of printing were not found to be block lettering or copybook, each of which accounted for only 10% of all the handprinting performed; instead, the participants chose to employ manuscript printing or printscript in equal overall proportions of 40%.

In the samples of disguised extended text, printscript was applied marginally more frequently than manuscript: 43% and 29% respectively. However, among the disguised signatures the reverse was found to be true as the large majority of writers (67%) preferred manuscript writing over printscript (33%).

At the outset of this study, it had been anticipated that individuals would not use handprinting as an alternative form of signing their names. However, a small proportion (10%) did elect to do so, and this proportion is the same as that found by Herkt in his study of disguised signatures. This suggests that handprinting as a method of disguising

signatures is not the unusual occurrence that Alford (1970) suggests it is, and that there will always be a small number of individuals who will attempt to disguise their signatures in this way.

The fact that printscript was the more popular form of printing signatures than any other is not, perhaps, surprising because it contains a combination of disconnected upper and lower-case letters and cursive writing (see Figure 12) which is not too dissimilar to the typical form of the naturally made signature.

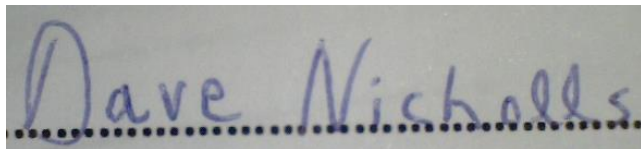


Figure 12: A Signature Disguised by Printscript.

6.1.8 Connecting Strokes Modification

In contrast to the high frequencies reported by Downey (1917) in her study of disguised handwriting, the deliberate alteration of connecting strokes in handwriting was not a method that was commonly employed by the participants of this study. The findings, which were consistent across both sample groups, revealed that only 13% of the participants deliberately modified their connectors. Furthermore, no participant was found to have used this method exclusively but rather used it in combination with other disguises.

The most common method by which participants modified the connecting strokes in their writing was to increase the quantity that they used in their writing (see Figure 13 and

Figure 14). 64% of those who deliberately made a change to their connectors increased the number they used by joining those letters and/or words that remained unconnected in their day to day writing, while 12% chose to omit them. The same proportion of participants (12%) introduced additional connectors while simultaneously omitting them from letters and/or words that they would normally join. Another 12% preferred to change curved connectors to more angular ones, a finding which contradicts Downey's claim that it is more common for connectors to be changed from angular strokes to a rounded ones (p.373), an occurrence that was not observed in this study.

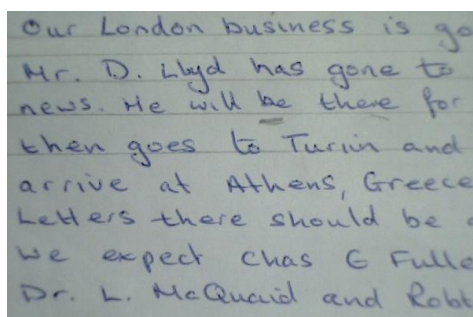


Figure 13: Connecting Strokes are Rarely Used in this Natural Writing.

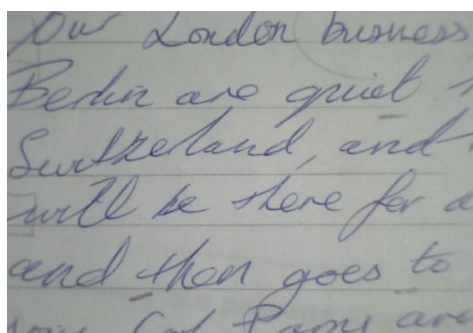


Figure 14: Connecting Strokes are Added as a Disguise.

6.1.9 Initial and Terminal Stroke Modification

Contrary to the strong evidence found by Alford (1970) in his study of extended disguised writing and by Herkt (1986) in his examination of disguised signatures, the proportion of subjects in this study that chose to alter the initial and/or terminal strokes of their writing as a specific disguise method was found to be significantly lower. Overall, only 12% of the subjects attempted modifications to these strokes. This method was used primarily in the samples of disguised extended writing (20%) since only 3% of the signature samples displayed deliberate alterations to the initial and terminal strokes.

In fact, the reduced proportions generated by this research correspond more closely to those reported by Wendt (2000) and Keckler (1997). The findings suggest that individuals either do not realise the significant impact that the presence or absence of these strokes can have upon the appearance of handwriting, or it may be that in anticipating the complexity of maintaining the consistency of this disguise they rejected this method as impracticable. This is certainly a possibility since none of the subjects who undertook such alterations were able to maintain their new strokes consistently.

Of those who did attempt changes to their lead in or end strokes, it was found that the initial stroke was altered far more frequently than the terminal stroke, a finding which accords with Alford (1970, p.483): This study found that 86% of the subjects altered the initial strokes and 14% altered the terminal strokes. Hayes (2006) has suggested that a writer's concentration will tend to be heightened at the beginning of letters, words and lines, and these present results would seem to support this claim since only one individual was found to have attempted alterations to the initial and terminal strokes simultaneously.

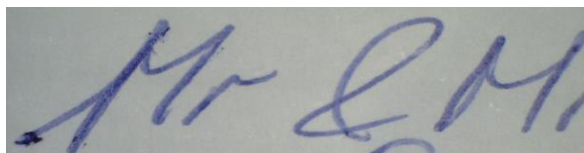


Figure 15: An Initial Stroke is Added to the Upper-Case ‘M’ Inconsistently.

Alterations to these strokes were limited to three types: deletion, addition and embellishment. The embellishment of the participants’ usual style of initial or terminal strokes was found to be restricted to the addition of loops or to the addition of angles, though the addition of loops was found to be the more popular choice since 43% of the subjects added loops to the normal structure of their strokes and 29% made their strokes more angular. Initial and/or terminal strokes were introduced as a disguise by 14% of the writers and initial strokes were omitted by the same proportion. There were, however, no instances of terminal stroke deletion.

No evidence was found to suggest that modifications to the initial and/or terminal strokes were confined to any particular letter or letters as Alford has reported (p.483).

6.1.10 Feigned Writing Care

An alteration of the degree of care used by writers to disguise their handwriting was employed by 10% of the participants overall, although it was a form of disguise that was more popular for disguising signatures (13%) than it was for altering extended text (7%).

Without exception, the natural writing of those subjects who chose this method of disguise was comprised neat, rounded letters, even spacing, with stable baselines and margins. The

combination of these features served to make their natural signatures and overall scripts legible and well organized. In order, therefore, to depart as far as possible from their usual writing hand, the writers all feigned carelessness by increasing the speed of their writing whilst relaxing control over their pens and paid little or no attention the formation of their letters or other writing features.

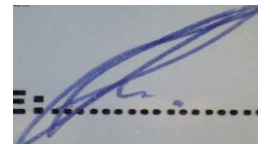
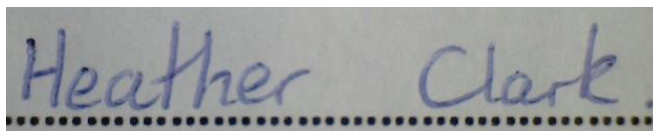


Figure 16: A Clear Natural Signature Becomes a Series of Lines in Disguise.

6.1.11 Use of the Non-Dominant Hand

It was noted in section 1.4.14 that remarkable consistency was achieved across the empirical studies with regard to the frequency of use of the non-dominant hand as a handwriting disguise since the majority of these studies found that 6% of their participants chose to employ this particular method. However, there was one study that reported a smaller proportion. Keckler (1997) found that only 3% of his subjects used their non-dominant hand as a means of camouflaging their natural writing and it was this proportion that was replicated by this current research. It was, furthermore, a figure that was consistent across both sample groups. In all cases the right hand was exchanged for their left.

The low frequency found rejects the view often made in the anecdotal literature that this method of handwriting disguise is one that is ‘frequently utilized’ (Koppenhaver, 2007, p.148).

6.1.12 Special Character Modification

Only 3% of the participants made deliberate modifications to the special characters in their writing, and this was a proportion that was found to be consistent across both sample groups. In all cases, the i-dot was the only character targeted for change. The way in which the writers altered this letter was the same and merely involved the insertion of i-dots into their disguises since it was usual practice for them to omit these in their natural writing.

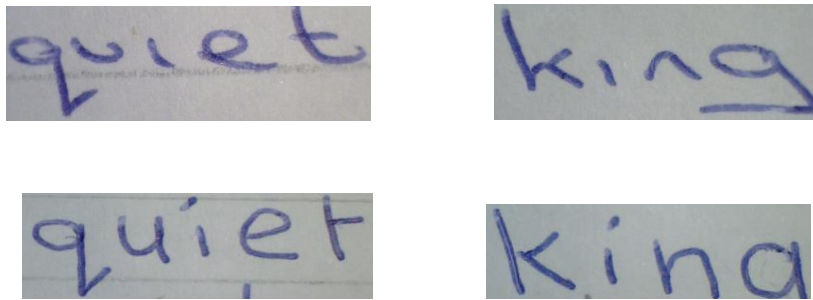


Figure 17: A Natural Lower-Case ‘i’ (top) Becomes Dotted During Disguise (bottom).

These findings support the generally held view that i-dots will be particularly targeted for deliberate alteration, although the incidence of change in this study was found to be much lower than those reported in previous studies (Downey 1917; Alford, 1970; Herkt 1986; Konstantinidis, 1987; Keckler, 1997).

6.1.13 Text Arrangement Habits Altered

The way in which an individual organizes their writing on a page is a generally fixed and unobserved characteristic, and this fact is borne out by the very low proportion of

individuals who deliberately sought to alter this feature of their writing as a disguise method.

Overall, only 3% of the participants attempted changes to the habitual way in which they arranged their writing, and in all cases disguisers endeavoured to change the spacing between letters, words and lines. There were no participants in this study that made any deliberate alterations to the baseline alignment of their writing as a method of disguise.

Alterations were observed in 7% of the samples of extended disguised text, but never in the samples of disguised signatures. The frequency of those attempting a change to arrangement patterns in this study is much lower than that reported by Downey (1917), Kropinak (1965) and Herkt (1986), but it is entirely consistent with those made by Wendt (2000) and Alford (1970).

6.1.13.1 Alteration of Lateral and Vertical Spacing Habits

In considering questions of disguise, the problem of whether observable changes to a writer's lateral and/or vertical spacing habits are due to a deliberate modification or as an unintended consequence of the particular disguise method employed, is one that has been highlighted in previous studies;^{cxxxv} but there is generally a lack of data with which to draw any firm conclusions either way. To eliminate such confusion as much as possible, participants were asked at the outset of this study to state explicitly the method or methods of disguise they intended to use. Any subsequent doubt as to the specific type of spacing disguise employed by an individual was allayed by a follow-up interview to establish the exact nature of their disguise and to determine whether or not their deliberate modifications

had been targeted exclusively at their lateral spacing, or whether they had, in fact, attempted changes to their vertical spacing habits as well, since the impact of disguise upon the vertical compression or expansion between written lines is not a topic that has been explored in previous empirical studies.

At the outset of this study, 7% of the participants stated that they intended to make changes to the habitual way in which they spaced their writing as a deliberate disguise method, with this proportion divided equally across both sample groups. However, in reality, only 3% made changes to the horizontal expansion or compression between their letters and words, or to the vertical expansion or compression between their written lines. It was also the case that these changes occurred only in the samples of extended disguised writing.

Of those that managed to make some change to their natural spacing habits, all were observed to have attempted an overall decrease in the lateral spacing of their writing as well as a decrease in the spacing between lines.

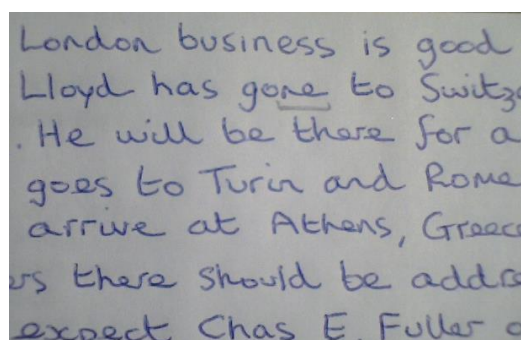


Figure 18: Evenly Spaced Natural Writing

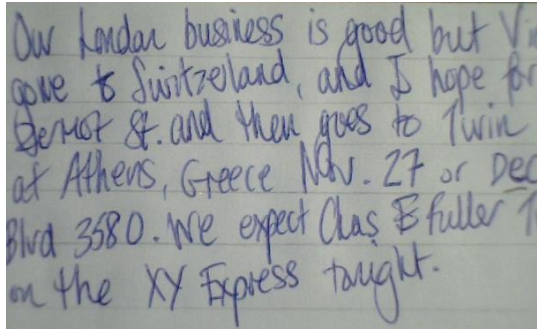


Figure 19: The Space Between Letters is Reduced as a Disguise Method.

6.1.14 Angularity Modification

No participants chose to alter the angularity of their handwriting as a means of disguise, a finding that contradicts that made by Alford, (1970)^{cxvvi} but which is in line with the lower frequencies reported by Kropinak (1965) and Herkt (1986).

6.1.15 Artificial Tremor

The deliberate introduction of tremulous strokes as a disguise method was not employed by any of the participants in this study.

6.1.16 Mirror Writing

The use of mirror writing as a disguise method was not employed by any of the participants in this study.

6.1.17 Pen Pressure Alteration

In section 1.4.16 it was seen that some confusion exists in the literature as to whether observed variations in pen pressure are as a result of deliberate modification or as an unavoidable consequence of the disguise process itself. To avoid such confusion, this study required every participant to fully describe the method or methods of writing disguise they employed, both before they embarked upon their disguise/s and also afterwards, to ensure that their methods did not alter at any stage during the disguising process. In the light of this, it was found that no participant deliberately modified pen pressure as a method for altering the appearance of their handwriting. This is an important finding since any variations in pressure observed can be conclusively classified as an identifying characteristic of disguise.

6.1.18 Use of Different Writing Instruments

Although a pen was provided in each survey pack, participants were not explicitly instructed to use that pen for writing their disguises. Nevertheless, none of the participants thought to use a different writing implement during the survey.

6.1.19 Omissions

The deliberate omission of letters in the disguise of signatures or extended text as a disguise technique was not used by any of the participants in this research.

6.1.20 Writing System Substitution and Deliberate Misspelling

As was expected at the outset of this research, no participants substituted their usual writing system for another as a way of altering their handwriting. The misspelling of words was also a tactic that was not used in any of the disguises examined.

6.2 Characteristics of Disguised Writing

6.2.1 Inconsistency in Disguised Writing

In section 2.2.1 it was noted that inconsistency is generally considered to be an important determiner of disguise and the results from this study fully justify this belief.

Two distinct types of writing inconsistency were identified: that which is caused by the failure of writers to maintain their chosen disguise, and that which occurs as an unintentional consequence of the process of disguise. The data generated by this research reveals that the overall likelihood that a disguised writing will exhibit inconsistency of the first type is 90%. This figure was somewhat lower for the signature samples (81%), but rose significantly for the samples of disguised extended text (96%). The overall likelihood that a disguised writing will exhibit inconsistency as a by-product of the disguise process was found to be 70%, a figure that was again found to be higher for the samples of extended disguised text (90%) than it was for the disguised signatures (50%), presumably because it is somewhat easier to maintain an unnatural writing for a shorter length of time.

6.2.1.1 Slant Variation

6.2.1.1.1 *Inconsistency of Assumed Slant*

In marked agreement with the empirical research conducted by Alford (1970) and by Jamieson (1983), an overwhelming majority of those who effected a disguise by changing the natural slant of their handwriting were unable to maintain their assumed slope consistently (94%), and this proportion was the same for both sample groups.

In all cases, slant inconsistency was caused by a reversion to natural writing habits. Reversions were observed to have occurred to individual letters and words, although in lengthier texts entire sections of writing sometimes reverted to the writer's habitual slant.

Letters that doubled in a word appeared to be problematic for the disguiser of longer texts, since these invariably reverted to the writer's natural slant (see Figure 20 and Figure 21). A high majority of the samples of extended text (84%) displayed reversions to the writers' habitual slants during the following letter combinations: 'll'; 'oo'; 'ss'; 'ee' and 'rr'. This is a characteristic of disguised writing that has not been previously identified in the literature and, notably, was not a feature that was observed in the signature samples.

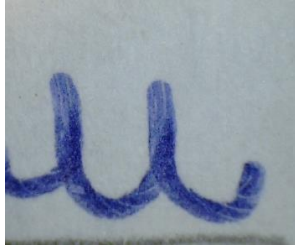


Figure 20: Disguised Double 'l'.

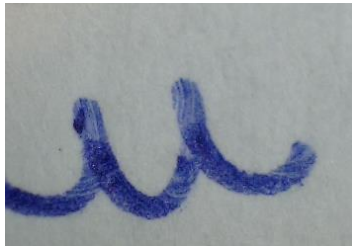


Figure 21: Reversion to Habitual Double 'l'.

No other patterns emerged as to whether reversions to a writer's normal slant would occur typically at the beginning, middle or end of a piece of disguised writing. In fact, the disguised slant assumed by some writers reverted to their habitual slope from the outset of their disguise. This observation challenges that made by Harrison (1966) and Jamieson (1983) who maintain that a disguised slope will tend to be constant at the outset but will deteriorate as the writing progresses and revert to the habitual slope of the writer.

It has been stated that the consistency of a disguised slant can be maintained when it is the only alteration that is made to a writer's usual script (Halder-Sinn and Wegener, 1992); but the evidence from this research strongly suggests that this is not the case. The participants generally found it difficult to maintain any level of consistency in their assumed slant, regardless of whether slant modification was the only disguise tactic employed and irrespective of the length of the writing disguised. This finding was

unexpected as it had been anticipated that writers would be able to maintain an assumed slant consistently for short periods such as during the disguise of a signature which possesses a comparatively short amount of writing. However, even in those cases where participants chose to disguise their signatures solely by changing the way in which they slanted their writing, a large majority of them (75%) were unable to maintain their new slope. Furthermore, in every one of the writing samples where altered slope was the only disguise method used, it was observed that as the amount of writing increased, so the disguised slant deteriorated.

According to Halder-Sinn and Wegener (1992), when the disguising task becomes more difficult, that is when an attempt is made to alter two or more elements of the writing simultaneously, so the disguised slant will become more vertical (p.479). However, this study did not provide evidence with which to support this claim. On the contrary, the findings reversed those found in the 1992 study. Of the disguised samples in which an alteration to the writer's normal writing slant was the only disguise method employed, 50% of these became more vertical. When, however, other elements of writing were disguised simultaneously with a change of slant, this figure fell to only 18%. It is not apparent why this should have been the case, but the results confirm that the process of changing one's habitual writing slope is just too complex for the majority of writers to achieve successfully, regardless of the complexity of the task involved.

6.2.1.1.2 *Summary of Findings*

It is to be expected that when writing slant is deliberately altered, a reversion to the writer's habitual slope will be evidenced during the script or signature. When the writing is lengthy, reversions can be expected in individual letters and words as well as in entire sections of text. Particular attention should be given to any double letters in a script, especially where their slope is found to vary from the overall slope of the rest of the writing, as this can serve as an important indicator of disguise and provide the examiner with valuable comparison material should an attempt be made to identify the author.

6.2.1.1.3 *Slant Inconsistency: Where no deliberate alteration of writing slant has been attempted*

Among the individuals who made no attempt to modify their natural handwriting slant, over half their disguised samples nonetheless exhibited slant inconsistency (58%). This was more prevalent among the samples of disguised extended text (75%) than it was among the disguised signatures (42%), but across both groups it was found that the majority of these samples displayed writing slopes that shifted erratically between forehand, backhand and vertical slopes before returning to the writers' habitual slants (79%). Only 14% of the samples displayed intermittent changes, and these were always of a more forward slope than the writers' usual writing slant, while the remaining 7% displayed shifts only to a more vertical slope.

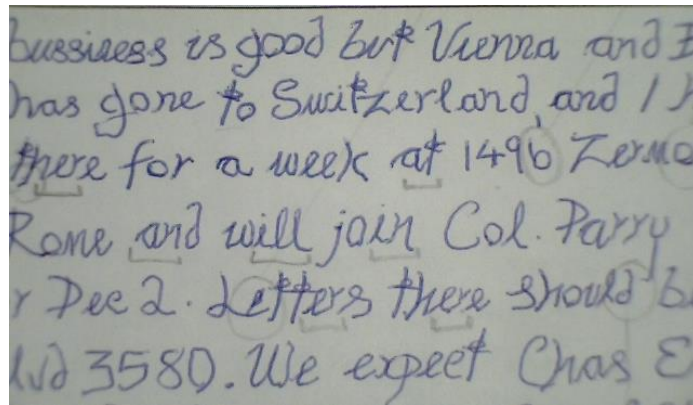


Figure 22: Unintentional Slant Variation in Disguise.

There were four methods of disguise associated with slant variation: 1) letter form modification, 2) an alteration of writing speed, 3) the use of the unaccustomed hand and 4) the alteration of speed. Across both sample groups, it was the alteration of form that appeared to be most detrimental to a regular writing slope since over half the samples disguised in this way exhibited erratic slant variation (58%); a deliberate alteration of speed produced 21% of the unintended slant variation, 14% was produced by the use of the unaccustomed hand, and 7% by an alteration of the writer's habitual speed.

6.2.1.1.4 *Summary of Findings:*

Writing that has been disguised by means other than an alteration of slant will often display a writing slope that shifts erratically between forehand, backhand and vertical slopes before returning to the writer's habitual slope.

6.2.1.1.5 *The Consequence of Slant Inconsistency*

In those samples where slant inconsistency was observed, a marked deterioration in the appearance of the disguised writing was apparent and occurred in both the disguised signatures and in the disguise of longer texts. Sudden, inconstant changes in the direction of writing slant imparted an awkward, uncontrolled, and ultimately unnatural appearance to the disguised writing.

The disguised samples in which slant had been deliberately altered revealed that the majority (85%) displayed a script that was strikingly arrhythmic and untidy as a direct result of erratic slant. Slant inconsistency occurred in almost the same proportion (86%) in those disguises where it was due to the disguise method employed by the writer. In all these samples, the appearance of the disguised writing had deteriorated beyond that which would normally be expected in typical natural writing: even that which has been written in haste.

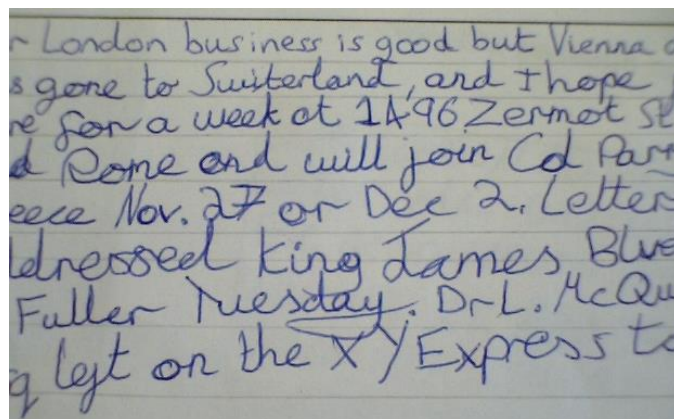


Figure 23: Inconsistent Slant (Note the horizontals of ‘T’ & ‘J’).

6.2.1.1.6 *Summary of Findings*

When the writing in a questioned document is unusually untidy and erratic and the appearance can be attributed directly to a constant shift in writing slant, this can serve as persuasive evidence that the writing has been disguised.

6.2.1.2 **Writing Size Variation**

6.2.1.2.1 *Inconsistency of Assumed Writing Size*

A great diversity in character size was observed in 78% of the disguised samples in which deliberate attempts had been made by the writers to alter the overall size of their handwriting. When the two sample groups were studied independently of each other, this figure rose dramatically to 100% in the case of the extended text samples. Inconsistencies were generally observed throughout the disguises, including from the outset of the writing, and few writers were able to maintain consistency in their assumed size for any length of time.

Writers were apparently better able to maintain their newly assumed writing sizes when smaller amounts of text were involved, such as in the disguise of signatures, since over half (57%) did so successfully; nevertheless, it was still the case that a reasonable majority of the participants were incapable of altering the habitual size of their signatures consistently. Given that the majority of the

target signatures contained relatively brief amounts of writing, this result was somewhat surprising since it had been supposed that most disguisers would be able to maintain uniform alterations to the size of their scripts for short periods. This finding reaffirms the view that the process of deliberately altering one's natural writing habits, such as size, is a task so inordinately hard that it will often lead to failure.

In the samples of extended text, and to a lesser extent in the signature samples, it was found that variations in size were often so extreme that the affected characters appeared wholly incongruous with those others appearing in the same text. In the lengthier specimens, this inconsistency was found to affect not just individual letters and numbers but also complete words and, on occasions, entire sections of text. It was significant that no attempts were made by the subjects to amend these extreme variations, either these writers did not perceive their errors or, and perhaps more likely, they did not recognize these as symptoms of inauthentic writing.

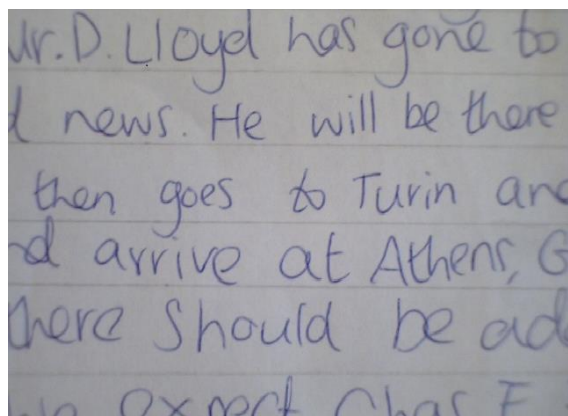


Figure 24: A Lack of Uniformity in Letter Sizing.

Certain letters proved especially problematic for the disguiser. In genuinely made writing it is usually the case that letters that are constructed alike are similarly sized, such as the lower-case mid-zone letters, ‘a’, ‘c’ and ‘e’. Nevertheless, it was observed that when the participants deliberately changed the overall size of their writing, these letters in common became noticeably haphazard in size.

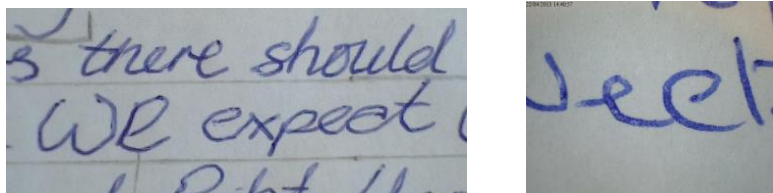


Figure 25: Incongruously Sized Letter ‘e’ by Different Disguisers.

Letter pairs also proved of evidential interest. These were frequently left undisguised, even when the sizes of other letters appearing in the same word had been consciously altered. Indeed, 71% of the extended writing samples displayed instances of this phenomenon, a majority that was significantly increased in the samples of disguised signatures (100%). In all cases, the disguises contained double letters that fell within the writers’ norm.

A return to a size of writing that was habitual to the writer was also observed to be a frequent occurrence elsewhere in many of the disguised samples. Exactly half of those who attempted letter size alteration as a disguise method reverted to their usual size of writing at some point in the disguise. This proportion was reduced among the disguised signatures, presumably because the smaller amounts of text did not provide the same opportunity for the phenomenon to

occur. Nonetheless, it was still the case that a reasonable number of participants (29%) produced characteristically sized letters in their signature disguises.

Across both sample groups it was found that many of those who disguised the size of their writing did not at the same time endeavour to alter the way in which they characteristically formed their letters. Consequently, the majority of the participants (64%) continued to construct their differently sized writing in a way that was entirely habitual to them, making it possible to link the writing with the writer.

The findings made here reflect the difficulty of implementing and maintaining enforced changes to the size of one's natural writing and indicate that the negative consequences resulting from such a task will be at once concomitant and inevitable in the majority of writings that are disguised.

The physical and/or mental inability of the disguiser to maintain an assumed size, together with constant, unintended reversions to a writing size that is habitual to them, will result unavoidably in a loss of the fluency and rhythm that commonly typifies genuinely made writing and will be manifest in a writing appearance that is at once haphazard and unnatural. For the handwriting examiner, such an appearance in a questioned writing should serve as a strong indicator of disguise.

6.2.1.2.2 *Summary of Findings*

It is to be expected that when writing size is deliberately altered the newly assumed size will not be maintained. Haphazard variations in letter size will occur and will often be so extreme that the affected characters will appear incongruous with others appearing in the same text. Inconsistency in lengthier texts will affect not only individual letters, numbers and complete words, but also entire sections of text. Letter pairs will tend to remain undisguised, even when the sizes of other letters appearing in the same word are disguised.

6.2.1.2.3 *Writing Size Inconsistency: Where no deliberate alteration of writing size has been attempted*

The data generated by this study provides evidence to suggest interdependence between writing size variation and the degree of conscious control that the writer is physically and mentally able to exert over the disguising process. Unnatural changes in letter size were not wholly restricted to those disguised writings in which a deliberate alteration of character size had been attempted, but were also symptomatic of other disguise methods. Indeed, of those disguised samples where no endeavour had been made by the writer to alter the overall size of their natural writing, 83% exhibited fluctuations in letter size.

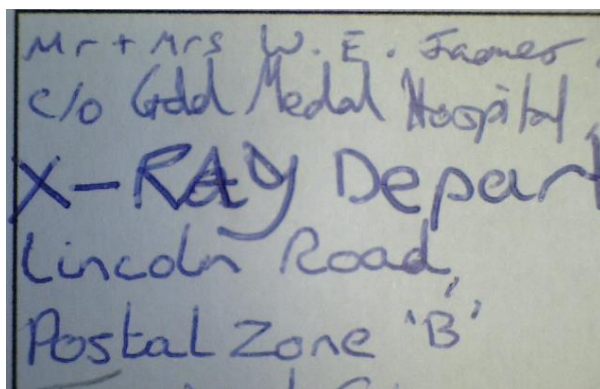


Figure 26: Inconsistently Sized Writing: Caused by the Disguise Process.

Downey (1917) has suggested a specific link between the disguise method of form alteration and involuntary shifts in letter size. She maintains that when a writer intentionally sets out to change the form of their letters, they will simultaneously increase the size of their writing, albeit unconsciously. Nevertheless, a review across both sample groups of the disguised writing in which form had been deliberately altered provided inconclusive results: 50% of the disguised writing overall increased in size; however, it is notable that when the two sample groups were treated separately, a general trend of enlargement (72%) was found to exist in the extended text samples, although this did not occur in the signature samples where the majority (71%) decreased in overall size.

Downey (1917) also suggests that disguised writing that has been camouflaged by means other than form alteration will generally lead to a smaller sized writing due to the increased 'effort of attention' (p.374) that inevitably accompanies any endeavour to modify natural handwriting. Hamilton (1980) has also suggested that a fraudster will often shrink their writing size because of 'a psychological desire to conceal his fraud by making it less easy to read'

(pp.264-265).^{cxxxvii} Nevertheless, the results from this study generally run counter to these views and indicate instead that such disguised writing will tend to increase in overall size (64%): at least in the case of lengthier passages of writing.

When the sample groups were looked at separately, it was found that the disguised extended text was much more likely to increase generally in size than the disguised signature samples. Indeed, 80% of the text samples displayed increases in overall size, whereas an examination of the corresponding signature samples provided inconclusive results with 50% of the signatures increasing and 50% decreasing in overall size.

6.2.1.2.3.1 Involuntary Size Change to Oval and Looped Structures

This study tested the claims made by Jamieson (1983) that looped structures would increase in size when natural writing slope was changed to a backhanded or reversed slant (p.121). However, in 97% of the samples, this was found not to be the case. The data collected did reveal that 22% of the samples exhibited loops that decreased in size when the writer increased their natural slope, but this, of course, still meant that the majority of loops did not. Consequently, the data from this study cannot be said to show a strong correlation between slope change and unintentional changes to the size of looped formations.

6.2.1.2.4 *Summary of Findings*

Unnatural fluctuations in writing size will tend to occur in disguises where no deliberate modification of the writer's natural writing size has been attempted. When altered form is employed as a disguise method, longer texts will tend to increase in overall size when compared with the writer's natural hand, while disguised signatures will tend to decrease in size. When disguises other than form and size have been used, an enlargement in writing size will also occur in the disguise of lengthier texts. Such size fluctuations will tend to impart a noticeably erratic and uncontrolled appearance to the writing.

6.2.1.3 **Letter Form Variation**

An analysis of the data showed that letter form variation occurred in 58% of all the disguised samples examined. Variation was found to be more prevalent among the samples of extended text (73%) than it was among the samples of signature disguise (43%).

6.2.1.3.1 *Inconsistency of Assumed Letter Forms*

Compelling evidence has been found with which to support the many claims made in the literature^{cxxxviii} that a writer's attempt to change familiar letter designs will prove to be a task so demanding, in terms of sustained physical and mental effort, that the endeavour will generally lead to marked inconsistencies in the writing. An unnatural irregular appearance was exhibited by all the extended text and signature samples in which deliberate

alterations had been made to the writers' letter forms, and this was caused by the writers' failure to adhere successfully to their artificial letter forms, and/or by their inability to overcome natural habit.

In those disguises where clear attempts had been made to alter the form of their letters, the internal consistency of the handwriting became repeatedly disrupted due to the fact that letter form modifications were not consistently reproduced either in their appearance or in the method of their construction. It had been anticipated that most writers would be capable of altering their letter forms effectively when the disguise contained only small amounts of writing since it is acknowledged in the literature that maintaining consistency in the formation of details generally tends to be more challenging for the disguiser of lengthier texts (Ellen, 1997, p.33). It was notable, therefore, that frequent discrepancies in letter formation were found in 100% of the disguised signature samples where letter form alteration had been attempted, even in those cases where the signature comprised very few letters.

It was also the case that the form of structurally related letters was often not similarly disguised. Overall, 69% of all the disguised samples in which form had been altered exhibited this discrepancy, and in the disguised extended texts, this figure rose to an overwhelming majority of 90%. In particular, the alteration of pairs and groups of letters, which in natural writing tends to be designed in the same way, appeared to be problematic for many writers. Even when successive instances of the same letter were written in close proximity, including alongside each other, these were frequently formed in

fundamentally different ways; sometimes, various unrelated designs were employed for the same letter, or embellishments and/or simplifications that had been made elsewhere in the text were later forgotten; but more often than not, the writer would inadvertently revert to a form of the letter that was entirely natural to them.

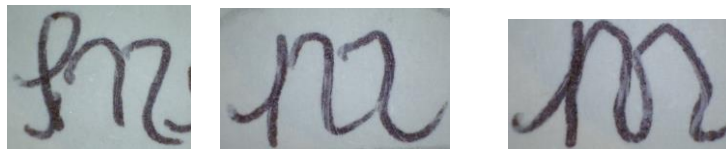


Figure 27: Inconsistency in the Disguise of the Letter ‘M’.

That the suppression of a writer’s habitual letter forms is ‘far less simple than it might appear’ (Harrison, 1966, p.355) is strongly supported by the results of this study which revealed that characteristic forms were present in 88% of the disguised samples collected, a figure that was higher for the disguised extended text (100%) than it was for the signatures (67%). Sometimes it was the case that such reversions would affect individual letters only, but in other instances whole words and even entire sections of text would revert to the writer’s natural characteristic hand, or would be neglected by them so as to remain wholly undisguised.

It has often been thought that letters occurring at the end of a disguised text, and/or at the ends of paragraphs, sentences and words, will contain more of a person’s individual writing habits than will be found elsewhere in the text (Quirke, 1930, p.79; Mansfield, 1943, p.25; Harrison, 1966, p.355; Hooten,

1990, p.19; Hayes, 2006, p.163). This phenomenon was, however, generally not observed in any of the disguised writing examined, including the samples of disguised extended text where such an outcome had been expected due to the larger quantities of writing involved.

It was, however, observed that many of these samples displayed characteristic letter forms at surprisingly early stages of the disguise, in some cases, as early as the first letter or word of the text (see Figure 28 and Figure 29); it was notable that no subsequent attempts were made by these writers to correct their initial errors. This wholly unexpected finding clearly supports the view that the ‘average writer’ is seemingly blind to the unique, natural elements of their writing, and that they will fail to appreciate the impact that the presence of these characteristics will have upon the overall success or otherwise of their handwritten disguise (Osborn, 1929, p.407. See also Brewster, 1939, p.114; Alford, 1970, p.476).

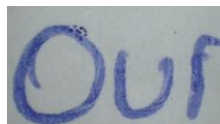


Figure 28: The First Word of the Naturally Written Sample Text.



Figure 29: The Letters of the First Word of the Disguised Text Fall Within the Writer's Natural Pattern of Variation.

It was noted in the previous section that no evidence was found with which to affirm a correlation between the complexity of the disguising task and a subject's ability to maintain their assumed slant uniformly. This was also the case in the samples of disguised extended text and signatures in which alternative letter forms had been used. Overall, 83% of the participants who had deliberately altered letter formation also employed one or more other disguise methods. It had been thought that conscious control over the production of alternative letter forms would reduce when two or more disguises were adopted simultaneously, and that this might account for the general inability of most of the writers to maintain consistency in their letter form substitutions; but the results showed that even in those samples where letter form alteration was the only disguise method used, and this included both extended text and signature samples equally, 100% of them exhibited inconsistent letter forms.

The results affirm that to set aside one's natural writing habits to modify or replace them is a task not easily achieved, and that features that are strongly characteristic of the writer will generally show through the majority of written disguises where letter form alteration has been employed. This is a particularly significant finding since it strongly suggests that provided sufficient exemplars of a suspect's natural writing are available for comparison, it should be possible for the handwriting examiner to be able to identify the author of such disguised writing.

6.2.1.3.2 *Summary of Findings*

Regardless of the length of writing involved, writing that has been disguised by form alteration will exhibit frequent and inconstant changes in the design and structure of its letters as letter forms revert back to that which is natural for the forger. Assumed form inconsistency will be found throughout disguised texts, but will frequently be observed from the outset of the writing. Constant variation in letter form will impart an uncontrolled appearance to the writing.

6.2.1.3.3 *Letter Form Inconsistency: Where no deliberate alteration of form has been attempted*

Of the writing samples that were disguised by means other than an alteration of form, 43% exhibited letter form inconsistency, and this was a feature that was found to be more prevalent among the samples of extended text (60%) than it was among the disguised signatures (29%).

The inconsistency observed always occurred as a result of a loss of pen control as the writer struggled with their newly assumed writing method, and this resulted in the appearance of unusual or grotesque letter forms that appeared highly incongruous with other writing in the text or signature.

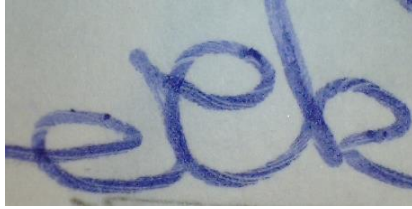


Figure 30: A Loss of Pen Control Creates an Incongruous Letter ‘e’.

It was notable that there were only four methods of disguise that had a negative impact on letter form consistency: 1) an alteration of slant, 2) an alteration of size, 3) an alteration of writing care and/or 4) the adoption of printing. Across both sample groups it was found that the participants who were at most risk of producing significant letter form inconsistency were those who deliberately altered their natural writing slant (50%), although signatures disguised by this method were marginally more likely to be affected by this phenomenon (56%) than disguised extended text (44%).

6.2.1.3.4 *Summary of Findings*

Letter form inconsistency, particularly in lengthier texts, will tend to occur in writing that has been disguised by means other than form alteration. Unusual or grotesque letter forms will tend to occur which will be incongruous with the other writing in the script. Such inconsistency will impart an uncontrolled, unnatural appearance to the writing.

6.2.1.4 Inconsistent Writing Velocity

6.2.1.4.1 *Inconsistency of Assumed Writing Velocity*

Contradictory signs of speed were found in 100% of the samples of extended writing where the writers had attempted to manipulate their usual speed of writing. A little more consistency was observed in the samples of disguised signatures (17%), which may suggest that when the quantity of writing to be disguised is small, it is somewhat easier for the writer to maintain a slower or faster writing speed than that which is natural to them. Nevertheless, it is still the case that the large majority of disguised signatures (83%) displayed writing that had been performed at varying speeds, a fact that seems to confirm this to be an element of writing that is not easily modified.

Dines (1988) has stated that a deliberate increase in writing speed can have a detrimental effect on the appearance of a text (p.280); but the results from this study suggest that any change to a writer's natural speed will cause the disguised writing to become unusually untidy and unnaturally erratic in appearance since a distinct lack of writing control was observed in the large majority of all the disguised samples (83%), including in those where the participants had decreased their usual writing speed. Nevertheless, all the disguises that were produced with an extreme acceleration of speed became illegible in parts, to a greater or lesser extent, and contained a greater proportion of poorly formed and distorted features than those disguises where a deceleration had been endeavoured.

In over half the disguised samples where speed modification had been attempted, the writers' newly assumed speeds reverted back to that which was habitual for them. Across both sample groups, it was found that of those who did revert to habitual speeds, 71% did so towards the end of their disguised writing, while 29% displayed reversions throughout their disguised text. This finding reinforces a general consensus in the literature that revealing lapses of conscious control will typically be found towards the end of a document (Quirke, p.79; Hooten, 1990, p.19; Mansfield, 1943, p.25; Hayes, 2006, p.163).

6.2.1.4.2 *Summary of Findings*

Contradictory signs of speed will typically be observed in texts that have been disguised by means of altering natural writing speed, regardless of the length of the text involved. Writing speeds will revert to that which is natural for the writer and this will tend to occur towards the end of the disguised text. Any change in writing speed will result in an unnaturally erratic and untidy appearance, and extreme accelerations in speed will lead to writing that is illegible in parts.

6.2.1.5 Inconsistency in the Initial and Terminal Strokes

The results generated from this study suggest that deliberate attempts to modify the initial and/or terminal strokes as a disguise strategy will inevitably fail. An examination of the samples of disguised extended text and signatures where such changes had been made

revealed that all the writers had been unable to maintain their new strokes consistently. Furthermore, across all the samples, and in agreement with Hayes (2006, p.166), a large proportion of the subjects (86%) reverted to habitual ways of forming or omitting their initial and/or terminal strokes, and these reversions were observed throughout their disguises. Indeed, one writer who stated explicitly that an alteration of initial and terminal strokes was her preferred method of disguising her signature wholly failed in the endeavour as every occurrence of these strokes fell well within her range of normal variation.

Significantly, 29% of the subjects who attempted alterations to their initial and/or terminal strokes touched in their modifications after completion of the letter or word in which the strokes appeared, and frequencies were consistent across both sample groups. The touched in strokes were relatively conspicuous and caused the writing to become somewhat erratic in appearance. This finding suggests that in real case situations such an observation should immediately render the writing suspicious.

6.2.1.5.1 *Summary of Findings*

Marked inconsistency will occur in the initial and/or terminal strokes when these have been disguised as writers revert to habitual methods of forming these strokes. Initial strokes will typically be affected more frequently than terminal strokes and any assumed alterations will often be touched in only after the letter/s or word/s concerned have been completed.

6.2.1.6 Inconsistency in the Upper and Lower Extenders

The results from this study strongly support the claim that deliberate alterations to the upper and lower extenders as a method of handwriting disguise will not be consistent. It was found that in the samples of extended disguise 91% of the subjects were unable to maintain alterations to these strokes uniformly, although better consistency was found among the writers of the signature disguises (25%) and it may be conjectured that the limited amount of writing made the task easier. Nonetheless, it was still the case that the large majority of these writers (75%) were unable to maintain uniformity when disguising these strokes.

Of those who were unable to maintain consistent changes to their ascending or descending strokes in longer texts, 90% reverted to their habitual manner of forming these strokes. Furthermore, over a quarter of these subjects (27%) altered the first occurrence of an ascender or descender at the beginning of a word but entirely overlooked those that occurred within a word. There were no instances, as Alford (1970) has reported, of writers altering only the extenders that occurred in the last letter of a word. There were no instances among the samples of disguised signatures of the writers having reverted to habitual forms of these strokes. In this sample group, inconsistencies were limited to the writers' inability to replicate their new strokes uniformly. Once again, it may be speculated that the relatively small amount of writing that comprises a signature prevented the disguisers from slipping back into their usual methods of writing.

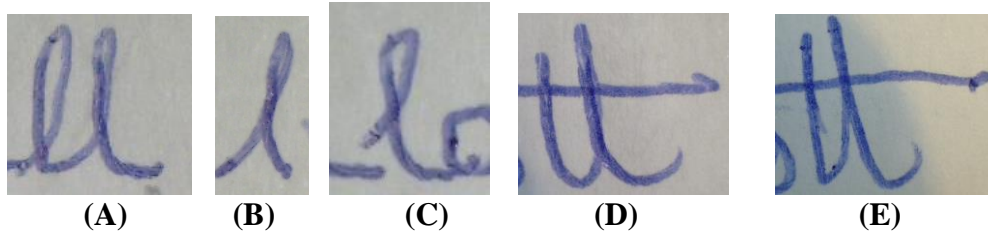


Figure 31: Inconsistent Upper Extender Disguise. Extenders in (D) have reverted to the Writer’s Usual Forms (E).

6.2.1.6.1 *Summary of Findings*

It is likely that marked inconsistency will be observed in the upper and/or lower extenders when these have been disguised. Inconsistency in lengthier texts will tend to occur as writers revert to habitual methods of forming these strokes; often, when the upper and/or lower extenders occur within a word, these will remain undisguised. In signature disguise, reversions to habitual methods of forming these strokes will typically not occur, but inconsistencies will continue to be present as the writers fail to replicate their new strokes uniformly.

6.2.1.7 **Inconsistent Text Arrangement**

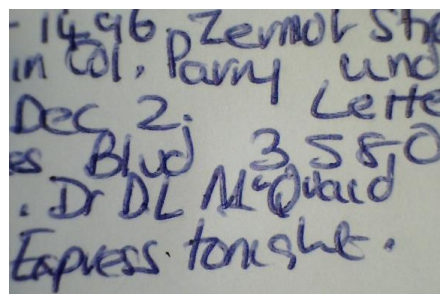
6.2.1.7.1 *Spacing Characteristics*

Some unexpectedly strong data was obtained regarding the spacing characteristics that are displayed in extended writing that has been deliberately modified. The findings give solid support to the claim made by

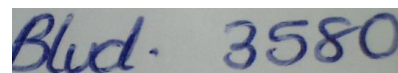
Huber and Headrick (1999) that inconsistent spacing is among the principal distinguishing features of disguised writing (p.284).

6.2.1.7.1.1 Lateral and Vertical Spacing Inconsistency: The product of a deliberate alteration of writing space

That the attempt to alter the way in which a person normally spaces the letters, words and successive lines of their writing is a task that is extremely difficult to accomplish successfully is borne out by the fact that of those writers who made modifications to this feature of their extended writing, 100% produced a script that was erratically spaced throughout. The irregularity of the spacing served to impart an uncontrolled, untidy and ultimately artificial look to the writing.



(A)



(B)

Figure 32: Inconsistent Spacing Disguise. Disguised spacing (A) Reverts to Natural Spacing Habits (B).

At the outset of this study, it had been thought that the way in which a writer spaced consecutive lines of writing was a characteristic that would tend to be overlooked by disguisers; however, the writers that modified their lateral

spacing also made conscious attempts to disguise their vertical spacing as well, although this endeavour also failed to yield consistent results.

In large part, the breakdown of the spacing disguises could be attributed to the writers' physical or mental inability to reproduce consistently newly assumed ways of positioning letters, words and lines, but in line with the findings reported by Alford (1970), it was also due to the fact that all the participants appeared to be unaware of many, if not all, of their idiosyncratic spacing habits since these were retained throughout their disguises, even when other spacing elements were modified. Moreover, 75% of those who stated that they would alter the lateral spacing of their letters and words as a disguise method, in reality entirely failed to do so and produced texts that fell well within the limits of their normal variation.

Significantly, reversions to habitual patterns of vertical spacing did not occur in any of the disguised writing where the writers' natural vertical spacing had been deliberately modified. However, their attempts to change the positioning of their writing lines on the page resulted in an irregular vertical spacing that differed substantially to the unvarying even spacing that could be observed in the writers' naturally written scripts.

6.2.1.7.2 *Summary of Findings*

Marked inconsistency will tend to be observed in the lateral and vertical spacing of extended text writing when these features have been deliberately modified as the writer is likely to be unable to maintain their disguise. Writers will frequently revert to natural methods of lateral spacing, but vertical spacing will tend to be generally haphazard. Spacing inconsistency will result in a writing appearance that is chaotic and unnatural.

6.2.1.7.2.1 **Lateral and Vertical Spacing Inconsistency: Where no deliberate alteration to spacing has been attempted**

Even when natural spacing had not been disguised, this feature often became markedly irregular as a direct consequence of the disguise process. Of the samples that were disguised by means other than an alteration of lateral and/or vertical spacing, 41% exhibited noticeably uneven spacing features.

In the samples of extended text, lateral spacing was observed to be more prone to accidental change (70%) than the spacing between consecutive written lines (30%) which tended to remain entirely habitual to the writer. In every instance, lateral spacing became haphazard as it fluctuated between that which was natural to the writer and that which was entirely random, in that individual letters, words, and sometimes complete sections of text were compressed or expanded indiscriminately. The occurrence of constant sudden

changes in a feature that is in natural writing relatively stable had the effect of creating an appearance that was at once chaotic and unnatural.

Inconsistencies were not dependent upon any particular type of disguise method as no specific disguise was observed to have had any greater influence on spacing patterns than any other. This was surprising as it has been said that when writing is disguised by an increase or decrease in the writer's natural writing speed, this will similarly produce an increase or decrease in the lateral spacing of the disguised writing (Jamieson, 1983; Keckler, 1997); however, this study found that everyone who altered their natural writing speed as a way of masking their handwriting characteristics actually retained their natural spacing patterns.

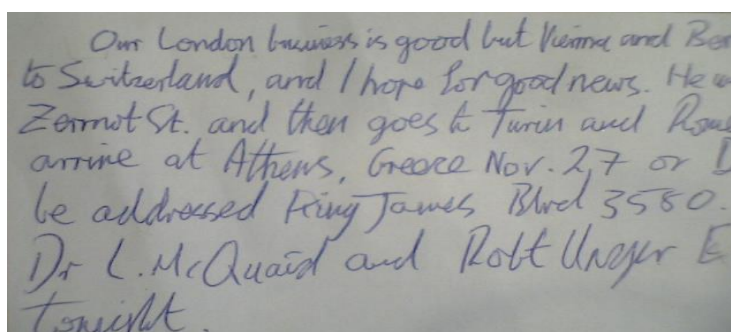


Figure 33: Inconsistent Lateral Spacing when Spacing is Undisguised.

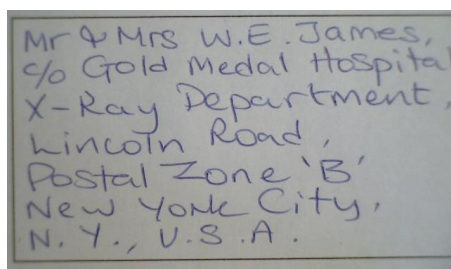
6.2.1.7.3 *Summary of Findings*

Writing that has been disguised by means other than an alteration of spacing will sometimes display obvious and persistent inconsistency in the spacing between letters and words, irrespective of the length of the writing involved

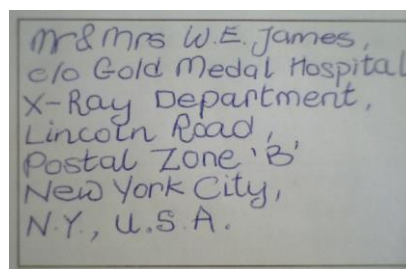
or the disguise method used. In extended texts, such inconsistency will tend to be accompanied by the more even line spacing that is generally characteristic of the forger's natural writing.

6.2.1.7.4 *Text Arrangement on Envelopes*

Of the small majority (8%) that attempted to disguise the arrangement of their writing in the address section of the test form, 100% failed to do so consistently and made constant reversions to habitual patterns of laying out their writing.^{cxxxix}



(A)



(B)

Figure 34: Natural Arrangement Patterns (A) Remain in Disguise (B).

6.2.1.7.5 *Summary of Findings*

The distinctive way in which writers arrange the writing on an envelope will tend to remain unmodified during disguise. Where attempts are made to alter the arrangement of writing, this will tend to be inconsistent as frequent reversions will be made to the writer's habitual method of positioning their text.

6.2.1.7.6 *Baseline Shifts: An Unintended Consequence of Other Disguises*

That the baseline of writing is a characteristic that is largely overlooked by those wishing to alter the appearance of their natural writing is confirmed by the results of this research since there were no participants who deliberately altered the way in which they aligned their writing to an actual or imaginary baseline. Nevertheless, the results indicate that the baseline is of evidential interest both as an indicator of disguise and as a characteristic that can assist in determining the identity of the disguiser.

Unintended changes to the alignment of the baseline were observed in just over half the extended text disguises (57%) and occurred regardless of the manner by which the participants disguised their writing. In 23% of these samples, the baselines were noticeably inconsistent in appearance, having no clear trend as to the direction of the line. A further 23% displayed writing lines that were gross exaggerations of the writers' usual baselines. For example, if the participant usually wrote with a gentle serpentine baseline, one that rose and fell moderately, the height and depth of the undulations would become greatly exaggerated from the moment the writer began to disguise their writing, and this imparted an uncontrolled, unnatural appearance to the writing.

The proportion of baseline changes among the samples of disguised signatures were found to be somewhat reduced as variations were observed in

only 37% of the samples, but it was notable that 64% of these displayed baselines that were extraordinarily erratic.

However, the strongest trend, in so far as the baseline alignment of disguised extended text was concerned, was that in general the process of disguise adversely affected the writing line by causing it to ascend upwards to the right. Of those extended writing samples in which baseline changes were observed, 54% displayed writing lines that shifted upwards. In addition, this study found evidence with which to support claims made in the literature that an unintentional directional shift upwards is directly linked to the employment of a specific method of disguise: the adoption of back slant. The writers of a large majority of those samples in which the baseline rose upwards (67%) had disguised their writing by adopting back slant, a proportion that precisely agrees with that reported by Jamieson (1983). On the other hand, this study found no evidence with which to support the claim made by Hayes (2006) that the writing line will inadvertently descend when the disguiser adopts a forward slope.

From the results, it appears that extended disguised text is somewhat more susceptible to the phenomenon of an upward directional change of the baseline than the disguised signatures; an analysis of these samples showed that 36% displayed unintentional changes to their normal baseline alignment upwards and to the right hand side, but no clear pattern emerged to indicate that this occurred as a direct consequence of the employment of any particular disguise method.

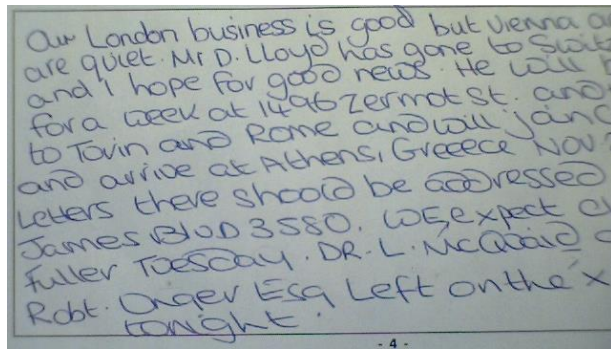


Figure 35: Disguised Text Baseline Moves Upwards to the Right.

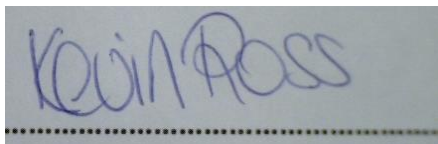


Figure 36: Disguised Signature Baseline Moves Upwards to the Right.

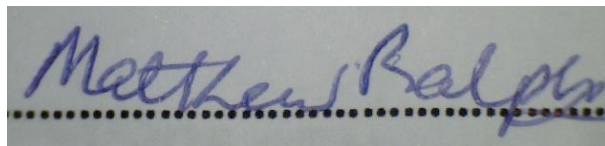


Figure 37: An Inconsistent Baseline Caused by the Disguise Process.

6.2.1.7.7 *Summary of Findings*

Inconsistencies in the baseline will often occur in writing that has been disguised by means other than baseline alteration. The direction of the line will become haphazard or will be gross exaggerations of the writer's natural baseline. In extended text, it will be common for the baseline to ascend upwards to the right, especially if back slant has been adopted as the disguise. Extreme variations in the baseline of a signature or extended text will produce an abnormally erratic appearance which should immediately render the writing suspicious and probably disguised.

6.2.1.8 Connecting Stroke Inconsistency

6.2.1.8.1 *Connecting Stroke Inconsistency: The Product of Deliberate Alteration*

Of those who attempted to change the appearance of the connecting strokes of their writing, none were able to do so consistently. Across both sample groups, connectors were touched in at places where the disguise had been forgotten (55%) and this was always accomplished after a word had been completed. In the extended text samples, the deliberate addition or omission of connectors tended to be performed inconsistently (67%), a finding that was not replicated in the signature samples.

Inconsistency was found, however, across both sample groups in those disguises where rounded connectors had been deliberately replaced by more angular ones. These strokes often displayed awkwardly made movements and an irregular slant as the writer struggled to maintain their newly assumed disguise (24%), although this characteristic was somewhat more prevalent in the samples of extended disguise (35%) than it was among the signature disguises (13%).

Inconsistency in the appearance of the connecting strokes also arose from the fact that the majority of writers (75%) repeatedly returned to their usual way of joining words and letters. Surprisingly, this occurred even when the

smallest amount of text was produced since half the individuals who disguised their signatures reverted to habitual ways of connecting letters.

The constant and often abrupt changes that were evident in the connecting strokes imparted an unnaturally clumsy appearance to the writing which in real case scenarios should alert the examiner to the possibility of disguise

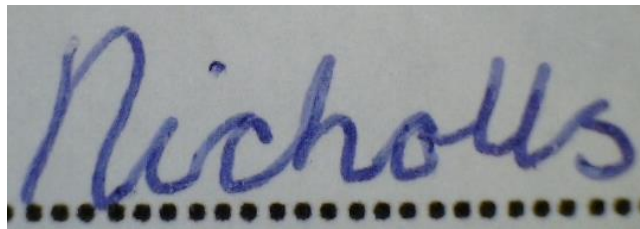


Figure 38: Uneven Disguised Connecting Strokes.

6.2.1.8.2 *Summary of Findings*

Attempts to disguise connecting strokes will typically be unsuccessful. Strokes will tend to be produced with awkwardly made movements and varying slants and will be frequently retouched. Inconsistency will commonly occur as writers revert to habitual ways of forming their connecting strokes. Constant changes in the connecting strokes will impart an unnaturally disordered appearance to the writing.

6.2.1.8.3 *Connecting Stroke Inconsistency: An Unintended By-Product of Other Disguises*

Where volunteers had not reverted to habitual ways of writing their connectors and had not made any conscious attempts to modify them, it was observed that the application of other disguises had had a negative impact upon the formation and pictorial appearance of these strokes. 50% of the disguised samples exhibited connecting strokes that were inconsistently slanted and that were made with unnaturally abrupt and awkward movements. This appearance contrasted sharply with the smoothly made and, in general, consistently slanted connectors that were observable in the participants' natural writing. It was found that in longer texts there was an increased likelihood of error in the formation and slant of the connecting strokes since this was a characteristic that was more evident in the samples of extended disguised writing (63%) than it was in the disguised signatures (39%).

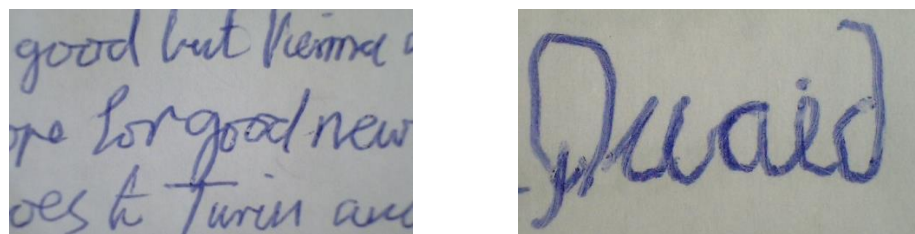


Figure 39: Awkward Connections as a By-Product of Disguise.

6.2.1.8.4 *Summary of Findings*

The process of disguise will often affect the slant and movement of connecting strokes, even when these have not been deliberately altered.

Awkwardly made movements and inconsistent slant may occur especially in the disguise of lengthier texts.

6.2.1.9 Numeral Inconsistency

Among the 40% of individuals who were apparently aware of the individuality of their written numerals and made deliberate attempts to modify them, 100% failed to do so consistently. Sometimes, successive appearances in a text of the same number would reveal that it had been disguised differently each time, although, more commonly, successful alterations would be made to one or two numbers while all others remained entirely characteristic to the writer. This was the case in 92% of the disguised samples and was evident in the design of the numbers, their formation, speed, pressure, shading and arrangement.

The date and time sections of the survey were of particular interest since these were either left entirely undisguised (67%), or they exhibited alterations only to those numbers that occurred at the beginning. Significantly, the numbers at the end of these sections remained wholly characteristic and attributable to the writer (33%).

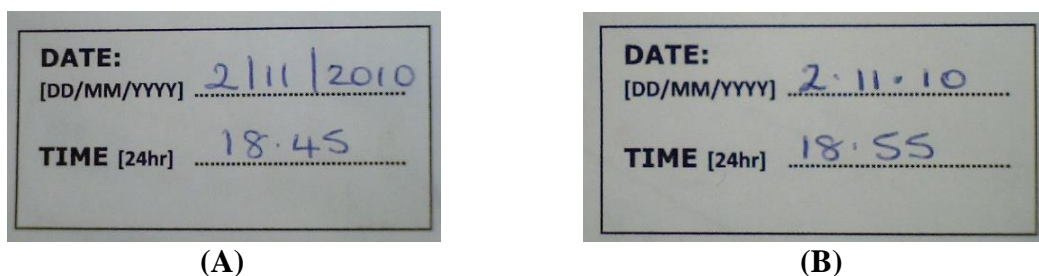
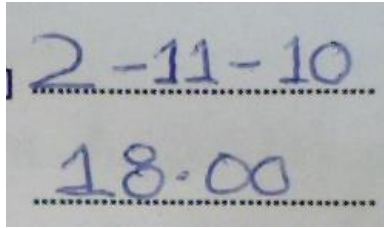
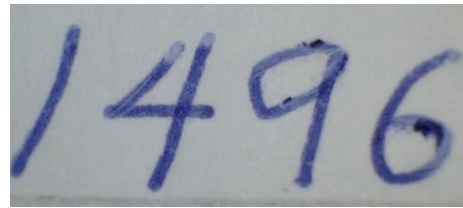


Figure 40: Naturally Made Numerals (A) Remain Undisguised When Other Elements of the Writing are Disguised (B).



(C)



(D)

Figure 41: Disguised Numerals (C) Revert to the Disguiser's Natural Hand (D).

6.2.1.9.1 *Summary of Findings*

Attempts to disguise the numerals in a text will typically be unsuccessful. New designs will be produced inconsistently and the writer will frequently revert to habitual ways of writing. Numerals occurring in dates and/or times will tend to remain entirely undisguised or will exhibit alterations only to the numbers occurring at the beginning of the date and/or time.

6.2.1.10 **Proportional Inconsistency**

Proportional changes occurred in 17% of the disguised samples when no deliberate attempt had been made to disguise this element of handwriting. Occasional erratically proportioned letters were found throughout the disguised extended scripts and/or signatures, and these were apparently caused by a loss of pen control as the writer struggled to create and maintain a new style of writing. Nevertheless, instances of such errors were infrequent and the remainder of their writing displayed proportions that remained the same as that found in their natural writing.

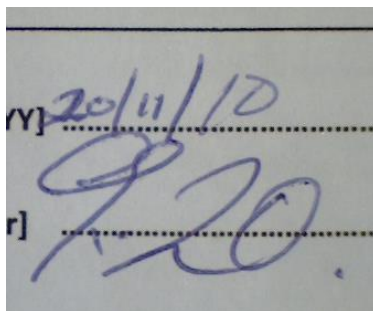
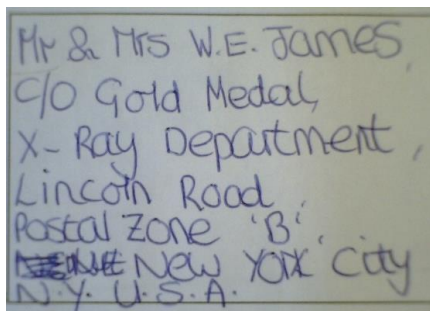


Figure 42: Erratically Proportioned Letters & Numbers Due to the Disguise Process.

6.2.1.10.1 *Summary of Findings*

Occasional erratically proportioned letters may sometimes be observed in disguised writing. Although this will occur rarely, several instances of this feature in a questioned text should alert the examiner that the writing has been unnaturally made.

6.2.1.11 **Special Character Inconsistency**

The few individuals who chose to alter their lower-case letter 'i' by adding or removing the dot above it, made no similar attempts to alter the dot above the lower-case letter 'j'. Furthermore, all these writers were unable to maintain their disguises during the course of their writing and would constantly revert to habitual methods of writing this letter.

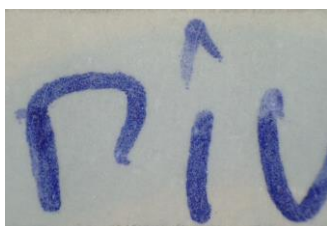
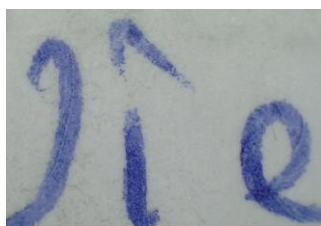


Figure 43: A Distinctive Natural 'i' Dot (A) Appears in the Writer's Disguise (B).

It was also the case that the writers made no attempts to change any of the other special characters or abbreviations in their writing, such as full-stops, commas, dashes or ampersands, but continued to write these entirely naturally throughout their disguises.

6.2.1.11.1 *Summary of Findings*

Attempts to disguise the special characters in writing will typically be unsuccessful. Commonly, modifications will be made to the ‘i’ dots, but other special characters may be overlooked. Any modifications that are made will tend to be inconsistent as writers revert to habitual methods of forming these characters.

6.2.1.12 Cross-Bar Stroke Inconsistency

Solid evidence has been found to support the claim made by Mikels (1971) that when the unaccustomed left hand is used to effect a disguise, many of the horizontal cross-bars, such as those found in the capital letters ‘E’ or ‘F’, will become wavy or erratic in appearance; indeed, this characteristic was found in every sample of extended text that had been disguised by this method. However, it was also observed that the disguise process generally had a negative effect upon cross-bar strokes that were usually produced as straight lines in the participants’ naturally made writing.

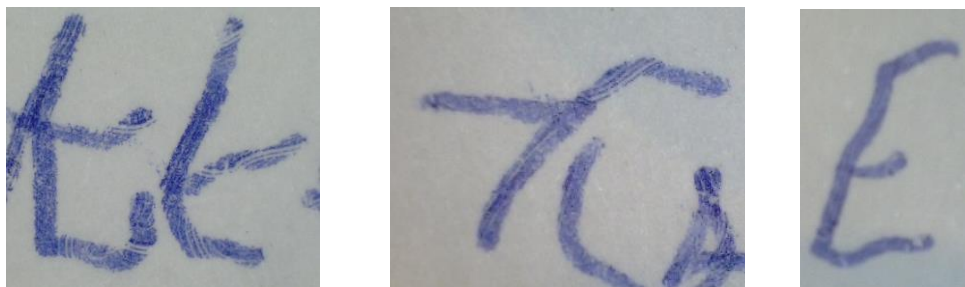


Figure 44: Awkwardly Made Cross Bars as a Consequence of the Disguise Process.

Overall, 45% of the disguised samples displayed erratically drawn cross-bars. This figure was higher in the samples of extended text (57%) than it was in the samples of disguised signatures (33%); however, this was to be expected since cross-bar strokes occurred more frequently in the longer texts.^{cx1} Nevertheless, in all cases, these normally straight strokes became wavy (81%), zigzagged (4%) or curved (4%), and/or were differently formed at each separate occurrence in the same text (11%).

It may be conjectured that the changes occurred to the cross-bars as a result of the writers' occasional, but inevitable, loss of pen control as they endeavoured to force the pen along unfamiliar paths and, for the most part, as they inadvertently wrote at speeds that were much slower than those to which they were used.

Both Mikels (1971) and Harrison (1962) have identified the cross-bars of the lower or upper-case 'T' as being of particular evidential value, but the data collected for this research did not indicate that there was a cross-bar in any one specific letter that was affected more frequently than any other.

6.2.1.12.1 *Summary of Findings*

Disguised writing will often display obvious inconsistency in its cross-bar strokes. These will tend to be awkwardly made and will become wavy, zigzagged or curved in appearance and may be formed differently at each separate occurrence in the same text. This is a characteristic that appears to be peculiar to disguise.

6.2.1.13 Handprinting Inconsistency

Of those who attempted to use an adapted form of printing, the great majority (80%) reverted to habitual printed forms at some point during their disguise. It was observed that when writing was prolonged, the disguised handprinting would revert sporadically throughout the text to a form that was natural for the writer which led to a distinctly uneven and unnatural appearance, but in the case of the signature samples, 100% of the writers simply printed their entire signature using a form of handprinting that was well within the limits of their natural variation.^{cxli}

6.2.1.13.1 *Summary of Findings*

Handprinting disguise will tend to revert to that which is natural for the writer, except when handprinting is used to disguise a signature, in which case the writing will commonly remain within the limits of the writer's natural variation.

6.2.1.14 Inconsistency Due to the Use of the Non-Dominant Hand

Much has been written about the use of the non-dominant hand as a disguise method, but there has, as yet, been no published empirical work on the characteristics that are produced in writing when this method of disguise is employed. However, according to data in an unpublished investigation into the effectiveness of different disguise methods, poorer writing quality will be caused by a change of writing hand (Kropinak, 1965, cited in Huber and Headrick, 2000, p.282). This assertion was tested and was found to be true for all the samples made with the non-dominant hand. In addition, other characteristics were encountered in the samples that were specific to this particular method of disguise.

The 'extreme distortion' observed by Dines in opposite hand writing was apparent in 100% of all the samples examined. Even though the subjects were all skilled in writing, the use of their unaccustomed hand caused them to produce disguises that significantly lacked fluidity and skill. All the disguises were written more slowly and more hesitantly than the writers' usual velocity which was manifest in the writing by a high incidence of angular curves, hesitation, pen-lift, heavy pen pressure, and blunted ends to the majority of initial, terminal, hooked and dragged strokes. Gross tremor was also present in the majority of strokes but was particularly found in curved and down strokes.

These elements can, of course, be found in other deviant writing and do not by themselves indicate that the writing has been made specifically by the non-dominant hand. However, this particular method of disguise generated errors in each individual sample that were more abundant and considerably more conspicuous than those occurring in texts disguised

by other means or than were found in individual samples of other forms of deviant writing.^{cxlii}

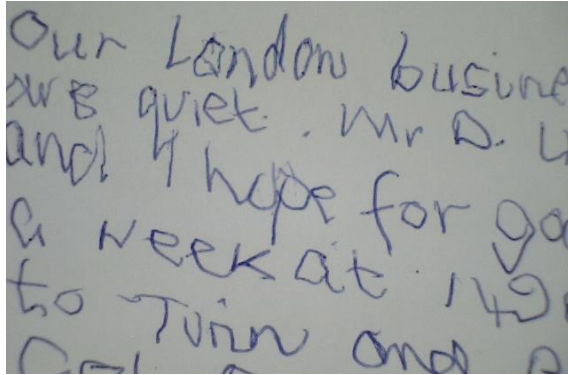


Figure 45: Writing Made with the Unaccustomed Hand.

Occurrences of hesitation and pen lift were highly visible in texts disguised with the unaccustomed hand; the writers appeared to have had great difficulty in controlling their pens sufficiently to enable them to place it back carefully on the paper to create the illusion of continuous writing. This caused more problems for the writer as they repeatedly had to patch their writing to mend breaks in what should have been continuous strokes. The writers appeared to be unable to make these patches delicately or to blend them successfully into previously written strokes which resulted in repairs that were clumsy and obvious. In addition, all the samples displayed instances of gross letter distortion which was often so marked as to make it difficult to discern the actual form of the letters concerned. Connecting strokes were also found to be erratic in slant, usage and proportion when the unaccustomed hand had been used; baselines, too, became similarly unstable and displayed extreme uneven shifts throughout the texts.

Section 6.2.1.12 noted that writers who were entirely proficient in producing consistently formed cross-bars in their natural writing were not so successful in doing so when disguising extended text with their unaccustomed hand. Indeed, the great majority of these strokes (98%) become irregularly slanted and/or undulating in appearance. Furthermore, it was observed that these strokes would sometimes be written in the wrong direction: from right to left instead of the writers' usual left to right stroke.

Several characteristics that were apparent in disguises made with the opposite hand were found to be unique to this method of disguise, although it should be noted that the 'smudge pattern' identified by Mikels (1971) as being peculiar to unaccustomed hand writings, was not anywhere observed in the samples examined for this study. There were, however, numerous extraneous hairlines observed in all the samples which is a characteristic that has not before been mentioned in the literature. These were highly visible and were found to bisect individual letters, numbers and words throughout the texts and were often found to be present in spaces that would in natural writing typically be left blank. This characteristic appeared to be caused by the writers' inability to lift the pen sufficiently from the page before starting a new stroke. This finding appears to confirm the assumption made by Wendt (2002) that the majority of those who write with the unaccustomed hand will not possess the ability to retain sufficient control of their writing instrument to allow them to produce an effective disguise (p.26).

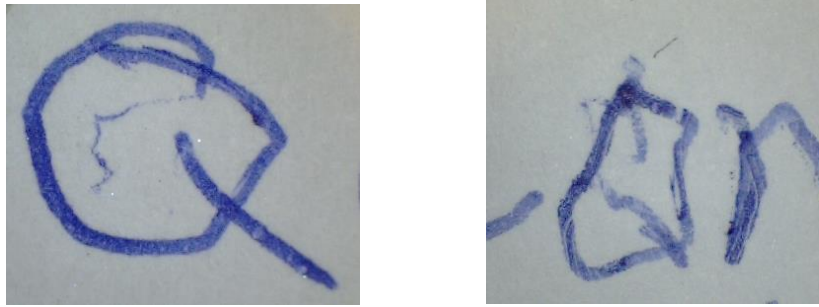


Figure 46: Extraneous Hairlines in Writing Made with the Unaccustomed Hand.

Some interesting findings emerged to support the assertion made by Conway (1959) that writing with the unaccustomed hand will cause ‘awkward counter-clockwise ovals and circles [...]’ (p.202). In all the samples examined, many of the writers’ ovals, which in their natural writing were made in an anti-clockwise direction, subsequently became clockwise in disguise. The letters ‘o’ and ‘q’ were particularly affected throughout the texts, as well as the numbers nought and nine. In one sample it was found that the capital letter ‘Q’ had been formed in two halves: one half moved in an anti-clockwise direction and the other in a clockwise direction. In addition, the ink lines of the majority of letters formed with ovals and curves were observed to oscillate, producing strokes that became alternately angular or zigzagged in appearance.

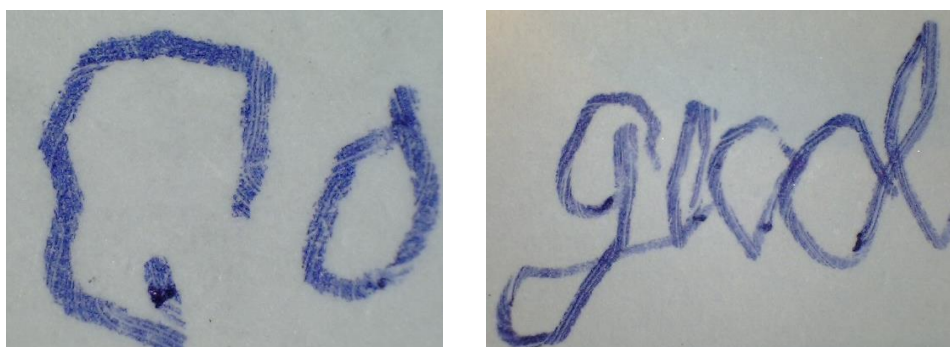


Figure 47: Angular Strokes: Caused by Writing with the Unaccustomed Hand.

Contrary to the assertion that unaccustomed hand writing will tend to be made larger than the disguiser's natural writing (Ellen, 1997, p.32), it was found that 100% of those who used this disguise method actually produced scripts and signatures that were smaller overall than their genuine writing.

Zimmerman (1995) concluded that 'when the intent in writing with the unaccustomed hand is disguise, such writers may believe the distorted appearance of the writing is sufficient' to hide their deeply-rooted writing habits (p.288). The data from this current research certainly seems to support this view. Despite the extreme distortion found in many of the written forms produced by the opposite hand, 100% of the samples included many of the writers' ingrained writing habits. Some subjects made no attempt to suppress these, whilst others stated that they had found it 'impossible' to change the way in which they habitually wrote. Special characters, such as i-dots and full stops, continued to be positioned in the writers' usual manner, and their arrangement patterns, which included the placement of margins, dates, times and signatures, remained unaltered. In addition, it was found that all the samples retained the same distinctive spacing patterns that were displayed in the writers' natural handwriting.

6.2.1.14.1 *Summary of Findings*

Handwriting that is disguised by means of the unaccustomed hand will tend to display errors in the ink line that are more abundant and considerably more conspicuous than those occurring in texts disguised by alternative means. The overall effect of so much variation will typically create a pictorial appearance

that is strikingly disjointed and arrhythmic. Even under the most cursory of examinations, such writing cannot be considered as in any way natural and will contain numerous features that are indicative of its having been written slowly and hesitantly. It will evidence gross distortion, erratically formed connecting strokes and cross-bars, tremulous strokes, and fine hairlines that bisect letters and words. Such writing will also tend to possess looped formations that move in an awkward anti-clockwise direction and possess an ink line that will be angular or zigzagged in appearance. Commonly, writers who disguise their writing using their opposite hand will fail to camouflage their idiosyncratic writing habits and, provided that sufficient and suitable exemplars are available to the examiner for comparison, these will enable the handwriting examiner to provide a strong opinion as to authorship.

6.2.1.15 Inconsistency Due to Feigned Writing Care

Every participant who sought to feign deliberate carelessness did so by increasing their natural writing speed while relaxing control over their pens. This inevitably reduced legibility to a considerable degree and created a text that was untidy and erratic in appearance.

It had been expected that the greater the carelessness with which the samples were made, the greater the likelihood that a determination of disguise would not be possible since such writing was expected to mimic the features of unrestrained natural writing. However, conspicuous hesitation marks were found in 100% of the extended text samples and in half

the signatures samples and served as particularly strong indicators that the writings were the product of contrived effort.

The hesitation marks revealed that the effort of writing at speeds that were considerably in excess of the writers' normal rates was problematic, and constant pauses were required to allow the writer to consider how to proceed in their task, or to reflect upon what they had already accomplished.

In addition, 100% of the samples of signature disguise were so badly scrawled as to be entirely illegible, an appearance that contrasted sharply with that of the subjects' genuine signatures which were all, without exception, written legibly in neat, well-formed letters. The samples of extended text were, for the most part, legible, but still contained distorted or indiscernible letter forms.

It is, of course, true that similar characteristics have been described in disguises made with the unaccustomed hand^{cxliii} and in writing that has been simulated; however, it is possible to distinguish between these features: whereas disguises made with less care display clear evidence of having been written at great speed, opposite hand writings and simulations will typically exhibit evidence of having been written very slowly (Lafone, 2005, pp.160-170).

The results from this study suggest that it is unlikely that the handwriting examiner will be able to identify the author of signatures disguised by careless execution. Because such signatures are typically scribbled and illegible, they tend not contain any of those idiosyncratic features that can help to associate the writer with the writing. The same

generally holds true for extended writing unless numerals are present in the questioned script. Every one of the samples of lengthier writing that was disguised by a writer feigning less skill than they actually possessed left some or all of the numbers in the text undisguised. Consequently, in agreement with Hilton (1982, p.223), the handwriting examiner should carefully examine any numerals in a script since this may provide valuable and ‘convincing’ identifying information.

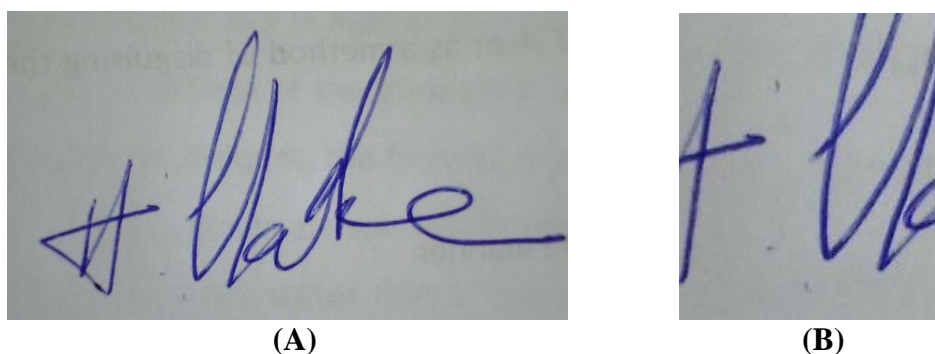


Figure 48: Feigned Carelessness Disguise (A). Note Hesitation Marks in (B).

6.2.1.15.1 *Summary of Findings*

Writings that are disguised by feigned carelessness will tend to exhibit clear evidence of having been written intermittently at great speed, but will be combined with conspicuous marks of hesitation. In addition, the occurrence of gross letter distortion and/or inconstant character sizing will generally result in a writing that is distinctly atypical. In real case situations, such an appearance in questioned writing should be regarded as strongly indicative of disguise.

6.2.2 Conclusion: Inconsistency in Disguised Writing

Striking inconsistency may be regarded as one of the major defining characteristics of disguised writing. It is to be expected that a deliberately modified natural writing will exhibit considerable variation in two or more of its writing features. Significant inconsistency tends to impart an erratic appearance to the writing which immediately reveals it as suspicious and probably disguised.

6.2.3 Degenerated Line Quality

The quality of the ink line proved to be a crucial indicator of whether writing had been disguised and this was true for both the extended texts and for the disguised signatures. Across both sample groups it was found that in every case the disguised writing displayed evidence, to a greater or lesser degree, of degenerated line quality. This finding supports the claims made by Regent (1979) and Hayes (2006) and closely accords with the experimental results reported by Kropinak (1965).

Contrary to expectation, degenerated line quality was found to be more common in disguised writing (100%) than it was in freehand simulations (91%; Lafone, 2005, p.112), although the types of errors found in the ink line were the same for both types of deviant writing. Disguised writing and simulations contained similar proportions of blunt ends, hesitation marks and pen lifts, but the disguised writing showed a higher proportion of overwriting and retouching, whereas simulations tended to contain more tremulous strokes.

The following sections discuss the findings relating to degenerated line quality in disguised writing more fully.

6.2.3.1 Involuntary Variations in Writing Speed and Pressure: An Unintentional By-Product of Disguise

Exceptionally strong findings were made with regard to the writing speed and pressure characteristics of disguised handwriting. Across both sample groups, a change in writing velocity occurred in 92% of the disguised samples where no deliberate alteration of speed had been attempted. In almost every instance a decrease in speed from that which was normal for the writer occurred simultaneously with a marked increase in writing pressure. Among the disguised signatures, 88% were involuntarily written more slowly, while the remaining 12% were produced at speeds that were typical for the writers. In the samples of extended text, 83% displayed a reduction in velocity compared with the writers' habitual norm, while 13% unintentionally increased it. A further 4% of these writers maintained habitual writing speeds while modifying the appearance of their writing.

All the samples in which accidental speed variation occurred exhibited an irregular appearance that contrasted sharply with the writers' naturally varying but consistent speed and pressure patterns. It was observed that when the pen slowed, unusually heavy writing pressure would be produced. This was manifest in darker, thicker ink lines which, in most cases, remained uniform throughout. Occasionally (in 9% of the samples overall), the belaboured, slow and heavy-pressured writing would be interspersed by brief interludes of more natural, variably shaded writing, although in the few samples where there was an accidental increase in speed (7% overall), a uniformly lighter pressure could be observed.

Accelerations of speed were always accompanied by characters that were unnaturally distorted or illegible.

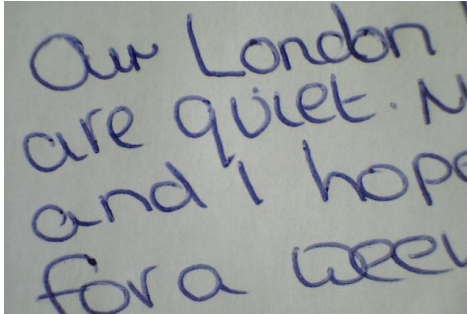


Figure 49: Uniformly Heavy Pressure Indicating a Slowly Made Disguise.

It has been asserted that reduced writing velocity and increased writing pressure will particularly accompany a deliberate modification of letter design or writing slant (Dines, 1998, p.99; Roberston, 1991, pp.140-141; Morris, 2000, p.172). However, this study found no correlation between the type of disguise employed and the speed or pressure at which the writing was made since nearly all attempts to change the appearance of handwriting were found to have adversely affected the speed and pressure of the finished product, regardless of the method of disguise employed.

6.2.3.1.1 *Summary of Findings*

It is to be expected that disguised writing will generally be made more slowly than genuinely made writing and will display less contrasting pressure.

6.2.3.2 Retouching and Overwriting

Repairs to the written line by retouching or overwriting were found to increase significantly during the process of disguise, although instances occurred predominantly in the extended disguised scripts.

The majority of these longer texts (60%) exhibited overwriting of individual letters and/or words, while a similar proportion (57%) displayed patching in the ink line. These figures were greatly reduced in the samples of signature disguise where only 3% exhibited retouched strokes and none at all contained instances of overwriting.

Very few participants overwrote or retouched strokes routinely in their natural writing, but when they did, occurrences were always low with no more than two examples in any one sample. On the other hand, a majority of the disguised samples (64%) exhibited a high frequency of these characteristics: the mean rate of occurrence for each disguise was found to be 18, with the highest recorded instance in any one sample being 60 and the lowest 3. There was, moreover, an average seven-fold increase in the incidence of unnatural repairs in the disguises of those who over-traced or patched strokes in their usual writing, even when these writers had successfully omitted their natural habits of retouching and overwriting from their disguises.

Nearly all the occurrences of retouching and overwriting (97% and 94% respectively) across both sample groups were accomplished meticulously, with delicate, careful strokes. This differed substantially to the natural occurrences of overwriting and retouching that

were observed in the control samples since these were all, without exception, performed casually and with apparently little regard for neatness or precision.

6.2.3.2.1 *Causes of Retouching and Overwriting*

The attempts to retouch disguised extended writing were made, for the most part, to maintain the integrity of the disguise (88%) by adding elements that the writer considered necessary to the overall cohesion of the disguise. Commonly, this involved the insertion of ornamentations such as loops, serifs, or other feigned characteristics that had been assumed at the outset of the disguise but which were subsequently omitted as the writing progressed



Figure 50: Retouching to Perfect Letter Form.



Figure 51: Retouching to Add Embellishment.

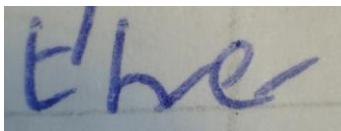


Figure 52: Retouching to Insert Connecting Strokes.

In the samples of disguised signatures, retouching was always applied to conceal some part of the writing that the participant recognized as being an identifying feature of their natural writing. Some attempts were made by the writers of extended text to correct errors that were caused by a relapse into natural ways of writing but occurrences were much less frequent than those in the signature samples (6%). In both sample groups, attempts to conceal distinguishing characteristics tended to concern only those features that were most noticeably apparent, such as particularly prominent letter designs, while less obvious elements were neglected.

Instances of retouching that had been made to improve legibility were found only in the samples of disguised extended text, although such occurrences were rare (6%). Invariably, these repairs were made to correct a gross fault in the movement of the line that had been caused by the participant's effort to write in manner with which they were unfamiliar.

Evidence of overwriting was found only in the samples of disguised extended text and was largely employed as a means to make the disguise appear more consistent (61%). One third of the writers attempted to overwrite certain features in their disguised writing that they believed could identify them and would often write over these elements several times; a minority (6%) of the participants also overwrote letters and words in an attempt to improve the legibility of their disguised writing.

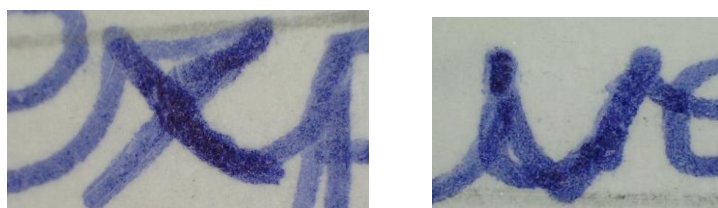


Figure 53: Overwriting in Disguised Writing to Correct Letter Forms.

6.2.3.2.2 Locations in which Retouching and Overwriting is Found

It has been reported in a study of the characteristics of freehand simulations that marks of retouching and/or overwriting will occur in only a few specific locations during the simulation process (Lafone, 2005, p.123), and that curved strokes and down strokes are particularly problematic for the forger since it is in these strokes that the highest frequencies are found. Up to a point, this was also found to be true for the examples of disguised writing, although it was the curved strokes rather than the down strokes that were particularly detrimental to the writers' overall attempts to create the illusion of authenticity in their disguises. Overall, 87% of all instances of unnatural overwriting and retouching were found in curved strokes with only 3% occurring in down strokes.

Instances of overwriting and retouching were never observed in the punctuation of natural handwriting, and yet this characteristic accounted for 10% of all the occurrences observed in the disguised samples. It is acknowledged that compared to some frequencies, 10% does not seem very high, but when it is considered that there were no instances of overwriting and/or retouching in the punctuation of the natural handwriting samples, the finding takes on a greater significance and suggests that any marks of retracing or patching in the punctuation of a questioned writing should be viewed as strongly symptomatic of disguise.

6.2.3.2.3 Retouching and Overwriting: Incorrect Line Direction

A characteristic that has been observed in the retouching and overwriting of freehand simulations has also been found in the samples of disguised writing. Of the writers who had incorporated overwriting and/or retouching in their disguised strokes over half (58%)

had done so with the pen moving in the opposite direction to that of the original stroke/s they sought to repair. This finding was, however, only observed in the samples of extended text and was never observed in the samples of naturally made writing.

The frequencies that have been found in this study concerning overwriting and retouching, particularly those relating to disguised extended writing, reinforce the findings reported by Downey (1917), Herkt (1986) and Leung et al. (1988) and reaffirm the importance that the literature has generally placed on such evidence as a valuable identifier of disguise.

6.2.3.2.4 *Summary of Findings*

Disguised extended texts will commonly exhibit a large number of delicately retouched or overwritten strokes, and these will frequently move in the opposite direction to the original stroke they seek to repair. Instances of retouching will occur much less frequently in disguised signatures, whereas overwriting may not be observed at all. The carefully retouched or overwritten strokes observed in disguise will tend to differ from that found in natural writing which is generally made more carelessly. More commonly, retouching and/or overwriting will occur in curved strokes but may also be found in down strokes and punctuation marks.

The presence of retraced and/or patched strokes in a questioned writing can serve to distinguish unnaturally made writing from that which is genuine, and

when such evidence is found in great quantity, it should be regarded as strongly indicative of disguise.

6.2.3.3 Hesitation

Marks of hesitation were observed in half of all the disguised samples and characterized the writing by a series of abrupt starts and stops where the writers had halted their flow of writing momentarily before moving on again. The presence of such marks in a questioned writing can be viewed as a particularly strong indicator that the writing is the product of contrived effort since instances of hesitation were never observed in the disguisers' natural writing.

It was found that hesitation marks were significantly more prevalent among the disguises of longer text (80%) than in the signature samples (20%), presumably due to the increased difficulty of maintaining a written disguise for any length of time. It was also the case that hesitation was in evidence more often in the extended text when the handwriting had been disguised by one of three ways: 1) an alteration of slant, 2) feigned carelessness, or 3) use of the unaccustomed hand. However, there was no evidence among the signature samples of a correlation between the type of disguise used and the frequency of hesitation marks.

Four different marks of hesitation were identified in the disguised writing samples and all but one of these, the ink blot, correspond to those that have been previously identified and described in writing that has been simulated (Lafone, 2005, p.119). Table 1 below details the percentage frequency of each type of hesitation mark and highlights the frequency

disparity that was found between the extended text disguise and the signature samples as to the type of hesitation mark that was most likely to occur.

Types of Hesitation Mark	Hesitation Marks Taking this Form (Extended Text) %	Hesitation Marks Taking this Form (Signatures) %
A firm clear mark found near or alongside a written stroke. See Figure 54 - (A) & (B).	54	20
An obvious ink blot on a written stroke. See Figure 54 – (C) & (D).	34	60
An indentation mark on a written stroke	8	0
A sudden short, jagged appearance to an otherwise smooth stroke. See Figure 54 – (E).	4	20

Table 1: Types of Hesitation Marks in Disguised Handwriting Samples.

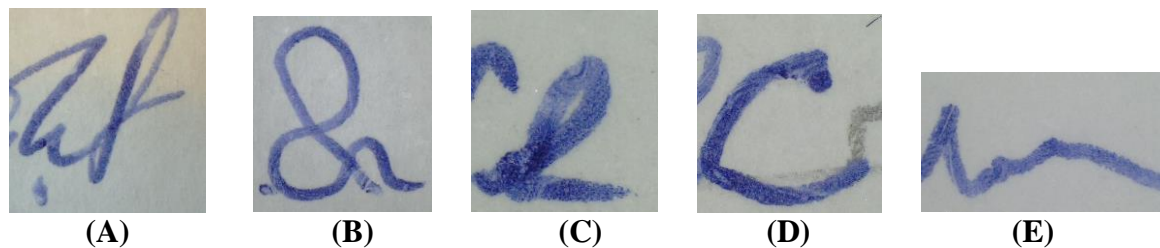


Figure 54: Hesitation Marks Observed in Disguised Handwriting.

Despite the fact that there are numerous places in handwriting where a writer might pause their pen, the data from this current study revealed that across both the sample groups, the incidence of hesitation occurred in only a few specific locations, and these are listed in Table 2 below.

Location of Hesitation Marks Across Both Sample Groups	Disguises Exhibiting Hesitation in these Locations (%)
Beginning of Down Strokes	60
Beginning of Initial Strokes	12
On the terminal stroke of one letter before starting the initial stroke of another	12
Curves/Looped Strokes	6
Beginning of Horizontal Strokes	5
Connector Strokes	5

Table 2: Location of Hesitation Marks in Disguised Handwriting Samples.

The locations identified in disguised writing correspond to those found in samples of simulated signatures (Lafone, 2005, p.120), although the locations were observed to be more limited in the samples of disguise.

6.2.3.3.1 *Summary of Findings*

Marks of hesitation, where the pen has paused on the paper, will commonly be found in disguised extended text. This characteristic will also be observed in signatures that have been disguised, but will occur less frequently. In lengthier texts, hesitation marks will tend to take the form of a firm clear mark near or alongside a written stroke, while in disguised signatures they will more often appear as an obvious ink blot on the written stroke. Hesitation marks in all forms of disguised writing will tend to be found at the beginning of down strokes.

6.2.3.4 Pen-Lift

Non-habitual pen-lift occurred in twice as many samples of disguised extended text (60%) than in the signature samples (30%). However, the frequency of occurrence increased in both sample groups as an involuntary consequence of the process of disguise, although this was found to be higher for the samples of extended text. The mean instance of non-habitual pen-lift in the disguised extended text was found to be seven, though pen-lift became more frequent when the writer used their unaccustomed hand or altered their natural letter forms to effect a disguise: the arithmetic mean being 13 and 9 respectively. Among the signature samples, the mean occurrence of non-habitual pen-lift was found to be two; this figure remained unaffected by the mode of disguise used and, consequently, there was no evidence to suggest that any one particular disguise would cause the writer to lift their pen more frequently than any other.

An increase in the number of pen-lifts also occurred in the longer texts when writers combined the use of disguise methods. When a single method of disguise was employed, the mean occurrence of non-habitual pen-lift was four, but this figure doubled when two or more techniques were used simultaneously. In contrast, the number of concurrent disguises had no effect on the occurrence frequency of pen-lift in the disguised signature samples.

Unnatural pen-lift was found to occur in only eight locations, although the signature samples displayed pen-lift in only three of these (see Table 3). Six of the locations accord with those that have been previously identified in the examination of simulated signatures (Lafone, 2005, p.116). Across both sample groups, connectors and curved formations

appeared to cause the disguisers the greatest difficulty since the majority of all pen-lifts occurred in these strokes (68%).

Location of Non-Habitual Pen-Lift		Incidence of Pen-Lift in each Location (%)
Connecting Strokes	(both sample groups)	40
Curved Strokes	(both sample groups)	28
Mid Letter	(extended text only)	8
Where directional changes in strokes occur	(extended text only)	6
Mid Word	(extended text only)	6
Horizontal Strokes	(both sample groups)	6
Angled Strokes	(extended text only)	3
Down Strokes	(extended text only)	3

Table 3: Location of Non-Habitual Pen-Lift in Disguised Handwriting Samples.

A slight tendency was found for the forger to replace the pen carelessly on the page after a pen-lift (54%). This finding is closely aligned with that reported for traced signatures and, indeed, for simulations.^{cxliv} Follow up interviews with the participants involved revealed that no attempts had been made by these writers to replace their pens with care to the page as they were simply unaware of their unnatural pen-lifts, and wholly oblivious to the significance that unnatural line breaks can have in an examination of a questioned writing.

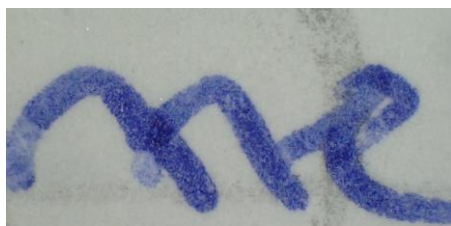


Figure 55: Unnatural Pen Lift in Mid Letter and Before Connecting Stroke.



Figure 56: Unnatural Pen Lift Before the Start of the Connecting Stroke to ‘l’.



Figure 57: Unnatural Pen Lift During a Connecting Stroke.

6.2.3.4.1 *Summary of Findings*

Disguised writing will frequently display numerous indications in its written line that the pen has been lifted from and returned to the paper. Pen-lift will also be encountered in signature disguise, but the frequency of occurrence will be much lower. Fraudulent pen-lift will be observed in places where their presence interrupts what would naturally be a continuous flow of writing. More commonly, evidence of fraudulent pen-lift will be found in the connecting strokes between letters and words and in curved strokes.

6.2.3.5 **Blunt Ends**

The process of disguise had a marked effect upon the appearance of the beginnings and ends of strokes that in the genuine writing samples were always finely tapered. In both the

extended writing samples and in the disguised signatures, such strokes would become clubbed or blunted in appearance, indicating that the writing had been produced at speeds that were much slower than that which was normal for the writers. Across both sample groups, it was found that the majority (80%) of those participants who did not ordinarily exhibit blunt ends in their natural writing did so in their disguised writing. Even among those who regularly produced blunt ends in their day-to-day writing and continued to do so in their disguises, 58% of them also increased the number of blunt ends that they unwittingly produced.

The disguised strokes in which blunt ends were commonly observed were found to be the same for both sample groups, and these are listed in Table 4 below.

Location of Blunt Ends	Percentage of Strokes Displaying Blunt Ends (%)
Initial Strokes	32
Terminal Strokes	32
Hooked Stroke	19
Dragged Stroke	17

Table 4: Location of Blunt Ends in Disguised Handwriting Samples

In the longer disguised samples there was a tendency (67%) for blunt ends to become more frequent when disguises were combined; it may be conjectured that since this would inevitably have created greater difficulty for the disguiser, their writing speed would involuntarily have slowed still further resulting in an increase in the number of blunted

strokes. No evidence was found, however, to indicate that the use of two or more disguises in signature disguise would increase the number of blunt ends produced.

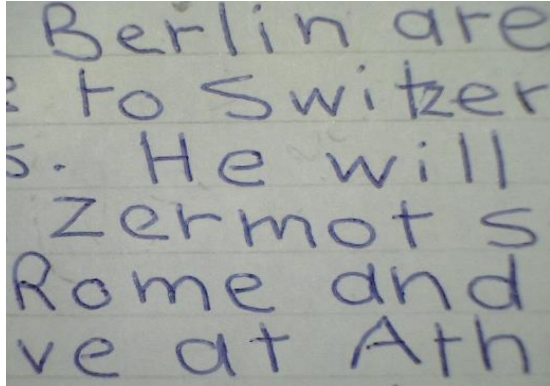


Figure 58: Disguised Writing Displaying Blunted Strokes.

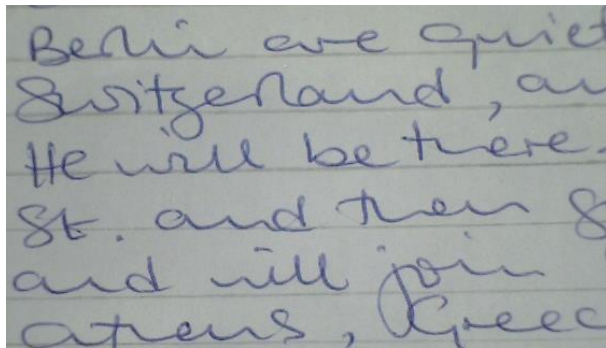


Figure 59: Natural Writing Displaying Tapering Strokes.

6.2.3.5.1 *Summary of Findings*

In the process of disguise, the finely tapered strokes that are generally indicative of unrestrained natural writing will tend to become clubbed or blunted in appearance. More commonly, blunt ends will be found on the initial and terminal strokes.

6.2.3.6 Tremor

Unnatural, intermittent tremor that is found in the ink line of strokes that are otherwise written smoothly is generally acknowledged in the literature as being particularly characteristic of artificially made writing (Brewster, 1932; Hilton, 1939; Osborn, 1946; Cardaciotto, 1992; Ellen, 1989; Nickel, 1996; Dines, 1998; Hayes 2006), and has been identified as one of the main distinguishing features of simulated signatures (Lafone, 2005, p.161). Nevertheless, this was not a characteristic that featured extensively in the samples of disguised extended text or signatures. Overall, 8% of the samples exhibited tremor, a figure that was the same across both sample groups. When tremor occurred, there was a slight tendency for it to be obviously apparent (51%) as opposed to finely made.



Figure 60: Tremulous Strokes in Disguised Writing.

The occurrence of tremor was observed in only a few specific strokes. These are listed in Table 5 below.

Location of Unnatural Tremor	Frequency of Occurrence of Tremor in these Strokes (%)
Curved Strokes	58
Down Strokes	27
Horizontal Strokes	11
Up Strokes	4

Table 5: Location of Unnatural Tremor in Disguised Handwriting Samples

An examination of the data revealed that tremor was significantly more abundant in those disguises that were made with the unaccustomed hand than in those made by any other means, and accounted for 50% of all the recorded incidents of tremor.

Nevertheless, the low incidence rate indicates that in general tremor cannot be considered a strong determiner of disguise, which might explain why it has not been subject to testing in previous experimental studies.

6.2.3.6.1 *Summary of Findings*

Tremulous strokes occur only very rarely in disguised writing, but when they do, it is likely that they will tend to be conspicuous and will occur more commonly in the curving strokes. Tremor will tend to be more abundant in disguises made with the unaccustomed hand.

6.2.3.7 Acute Angles in Curved Strokes

During the course of this study it has become apparent that curved strokes are particularly vulnerable to adverse variation caused by the process of disguising handwriting, and the results from this study are strong enough to suggest that it is a characteristic of disguise that should be investigated further.

The transformation of smoothly curving written strokes into ones that are acutely more angular in appearance is a phenomenon that has not been discussed before in the literature pertaining specifically to handwriting disguise, but is one that has been frequently observed in the study of simulated handwriting. The literature is in general agreement that angled curves are a common determining characteristic of this form of deviant writing, and is ascribed to the unintended reduction in writing speed that typically accompanies most simulations (Harrison, 1955; Ellen, 1989; Davis, 1989; Leung et al, 1993a; Nickell, 1996; Lafone, 2005). Nevertheless, evidence has been found in this research to suggest that this unnatural characteristic, which contrasts strikingly with most naturally made writings, can equally apply to writing that has been intentionally disguised.

Indeed, a majority of the disguised writing examined in this study (68%) exhibited curved strokes that had inadvertently become more angular as a direct result of the disguising process. This proportion was found to be broadly consistent across both sample groups.

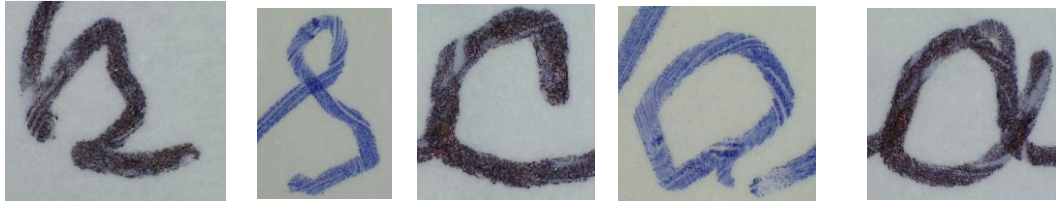


Figure 61: Smooth Curves Become Angled in Disguise.

In light of the fact that a large proportion of the disguised samples were found to have been produced at speeds that were lower than those that were customary for the writers (see section 6.2.3.1), the emergence of this characteristic is, perhaps, unsurprising and corresponds well to the findings for simulated writing. Of course, it can reasonably be argued that simulation is itself a form of handwriting disguise, in so far as the writer seeks to conceal their own writing characteristics whilst simultaneously taking on new writing characteristics. It is, therefore, not unreasonable to expect disguised writing to exhibit similar characteristics to those which appear in simulations.

6.2.3.7.1 *Summary of Findings*

The smoothly curving strokes that are generally found in natural writing will frequently become more angular as a direct consequence of the disguising process. Curves may be reproduced as a series of short, straight lines, or where a single change in the stroke direction has occurred the curve may become a single sharp point.

6.2.4 Conclusion: Degenerated Line Quality in Disguised Writing

It is to be expected that disguised writing will exhibit evidence of poor line quality. The smooth ink line that is generally characteristic of genuinely made writing will become noticeably uneven as it is affected by instances of many or all of the features that are indicative of a writing that has been made slowly and hesitantly. In particular, a lack of speed and pressure will be evident, blunt ends will be present and curved strokes will become more angular in appearance. Instances of overwriting, retouching and pen-lift will occur frequently in extended disguised texts, but less frequently in signature disguise, while tremulous strokes, contrary to other writings, was found to occur rarely, regardless of the length of the writing involved.

6.2.5 Characteristic Features of Natural Writing Remain Undisguised

6.2.5.1 Habitual Pen-Lift

An analysis of the data provided evidence that many writers are oblivious to where they naturally lift their pen when writing. All of those who displayed marked habits in regard to the location of their pen-lift/s and the amount of space they used before returning pen to paper in their natural writing continued to incorporate these into their disguises. Such an unexpectedly robust finding indicates that these idiosyncratic features of a person's writing can produce compelling evidence that can assist the expert in determining the author of a disguised writing

6.2.5.2 Habitual Blunt Ends

Writers who produce blunt ends in their natural writing will tend to incorporate these into their disguises. Of those participants who displayed marked habits with regard to where and how they created blunted strokes, 58% reproduced them in their disguises; this figure was higher for the samples of signature disguise (67%) than it was for the samples of extended text disguise (50%).

6.2.5.3 Habitual Letter Forms

It would seem to be self-evident that a disguised writing will exhibit more newly acquired forms than those which are natural and characteristic to the writer (Quirke, 1930, p.79),^{cxlv} but in signature disguise it seems that the reverse is true. In his study of disguised signatures, Michel (1978) reported that almost half his subjects failed to disguise their writing, and produced ‘signatures which fell more or less clearly into the acceptable range of their authentic signatures’ (p.28).^{cxlvi} This same phenomenon was also identified in the disguised signature samples of this present study, providing further evidence that writers do not see or understand the significance of their writing traits. In close agreement with Michel’s findings, half the participants who indicated in their questionnaires that an alteration of letter form was a method by which they disguised their signatures, in reality produced signatures that were entirely unaffected by disguise and remained within the limits of their normal variation. A further 15% of subjects made alterations to the letter forms of their signatures simply by substituting the usual manner by which they signed with a form of their natural cursive writing; it was, therefore, a relatively straightforward matter to match the writer to their writing. It was of particular interest, then, to find that

when questioned, the majority of these writers fully believed that they had made reasonably successful attempts at altering their handwriting.

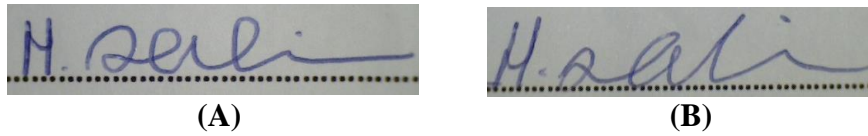


Figure 62: Disguised Signature (B) Remains within Writer's Natural Variation (A).

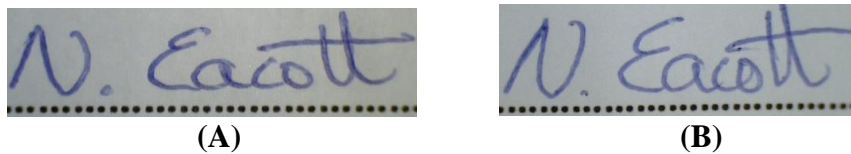


Figure 63: Natural Signature (A) & Disguised Signature (B) are Almost Identical.

That the perception of these writers should be at such odds with their actual performance accords with Zimmerman's (1995) claim that in general the disguiser will be confident, albeit mistakenly, that simple changes or distortions made to the appearance of the writing will be all that is needed to ensure their anonymity (p.288).

6.2.5.4 Habitual Upper and Lower Extender Strokes

Very few writers (25%) attempted to alter the habitual manner in which they formed their upper and lower extender strokes.^{cxlvii} In questions of disguise, therefore, such strokes should be carefully examined by the handwriting examiner as they may afford evidence with which to help associate a disguised writing with its author.

6.2.5.5 Habitual Spacing

That a writer's individual spacing characteristics will continue to emerge even when deliberate attempts have been made to conceal them has been discussed above in section 6.2.1.7.1.1, but analysis of the data shows that the vast majority of those who camouflaged their writing by means other than spacing alteration failed to appreciate the individuality of their spacing habits and made no attempt to alter them.

In every sample of extended text, the writers' natural word and/or line spacing was retained in whole or in part; this figure was reduced to 82% in the samples of disguised signatures, but still constitutes a high majority. Even when individuals deliberately increased or decreased the size of their writing, they unconsciously increased or decreased the natural spacing of their writing proportionately.

The findings that have been made are entirely consistent with those reported in the literature (Harrison, 1966; Alford, 1970; Hooten, 1990; Dines, 1998). They also support the view that spacing is a characteristic of writing that is generally unheeded by writers, and that consequently such evidence can be of significant evidential value in questions of disputed authorship, assuming that valid comparison material is available (Dines, 1998; Morris, 2000; Hayes, 2006).

6.2.5.6 Habitual Connecting Strokes

Across all the samples of disguised extended writing and disguised signatures, it was found that 87% displayed habitually connected letters when other disguises had been employed to

change the overall appearance of writing. A high majority of the participants who disguised their signatures (93%) either failed to appreciate that connecting strokes are an important characteristic of handwriting, or else found the task of modifying them just too difficult to accomplish. This figure was somewhat reduced in the samples of disguised extended writing, but it was still the case 80% of the writers failed to disguise their connecting strokes and continued to form them in their customary manner.

6.2.5.7 Habitual Text Arrangement on Envelopes

An address was incorporated into the disguise test sheet to ascertain whether or not the participants would recognize the importance of disguising this section of the form. It was found that although most writers (81%) did attempt to alter their handwriting during this section, the majority (92%) did not attempt to disguise the way in which they arranged the address on the page. In their genuine writing, all these writers exhibited very distinctive arrangement traits which they failed to modify in their disguises. Furthermore, a small proportion (19%) failed to disguise either the arrangement of their handwriting or the handwriting itself.

6.2.5.8 Habitual Special Characters

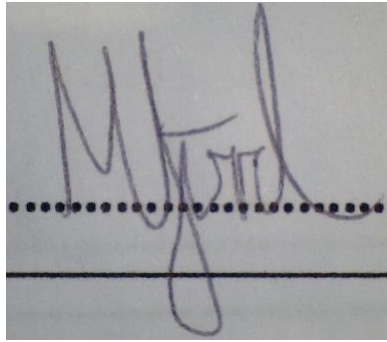
The fact that 97% of the participants in this study failed to alter punctuation marks, diacritics and abbreviations in their disguised writing strongly supports the conclusion that has generally been drawn in the literature that such marks will rarely be modified in disguised writing (Harrison, 1966; Alford, 1970; Alford and Bertocchi, 1974; Herkt, 1986; Keckler, 1997; Hayes, 2006).

Moreover, of the few writers that made some attempt to alter the occasional special characteristic, 100% reverted back to producing them in ways that were habitual to the writers. It is remarkable just how characteristic the great majority of writers were in their natural writing with regard to the placement, size and form of their special characteristics. Although this is something that has been highlighted previously (Harrison, Alford and Bertocchi, Hayes), it still seems surprising that so many are apparently blind to these particularly idiosyncratic elements of their writing, and leave them undisguised.

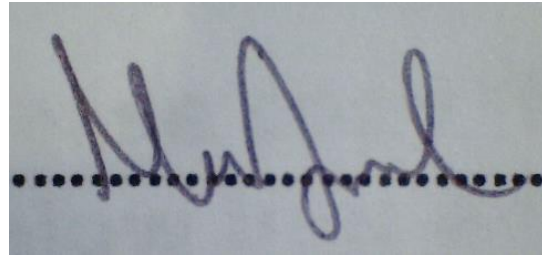
6.2.5.9 Habitual Baseline Alignment

It had been anticipated that while the disguisers of longer texts might neglect the natural baseline of their writing, those that disguised only brief amounts of writing, such as a signature, would be more aware of this characteristic and modify it accordingly, particularly as the natural baseline of the participants' natural signatures tended to be strikingly characteristic to each writer. In fact, 43% of the disguisers of extended text adhered to their habitual baseline alignment, a proportion that increased significantly in the samples of disguised signatures where a majority of 63% displayed baselines that were entirely habitual and attributable to each writer.

That an examination of the baseline of a questioned signature is 'all-important because it is remarkable how many writers are consistent in the way in which they position their signatures' (Harrison, 1967, p.114) is fully supported by the results of this study



(A)



(B)

Figure 64: Disguised Signature (A) Retains Writer's Habitual Baseline (B).

6.2.5.10 Habitual Numerals

Researchers Kropinak (1965) and Keckler (1997) have both reported that when handwriting is disguised the numerals in the text will tend to be overlooked and remain characteristic to the writer, and the results of this study support this conclusion. The majority of disguisers (60%) made no attempt to alter any of their numbers, even those who took particular care to make changes to all other aspects of their writing.

When writers feigned less care as a way of disguising their writing, it was found that every one of their samples of extended text contained numerals that were undisguised and formed in the writers' usual way. Indeed, half the samples contained no disguised numbers whatever, while the other half made only occasional attempts to alter just two or three numbers. Interestingly, the numbers in the date and time sections were always left undisguised in these samples, even when attempts had been made to alter numbers elsewhere in the text.



Figure 65: Natural Numerals (A & B) Remain Unchanged in Disguise (C & D).

These findings support the view generally held in the literature that the numbers in a text suspected of having been disguised will ‘provide valuable reservoirs of identification data’ (Conway, 1959, p.68) as they will tend to remain undisguised. It is important, therefore, that the handwriting examiner should take especial care to study them.

6.2.5.11 Habitual Terminal Strokes

In section 6.1.9 it was reported that initial strokes were targeted for alteration much more frequently than terminal strokes which tended to remain habitually formed. For this reason, it is important that handwriting examiners give particular attention to the terminal strokes since they will tend to impart important characteristic information about the writer.

6.2.5.12 Habitual Cross-bar Strokes

It has been suggested that close examination should be made of the horizontal strokes in a writing that has been identified as disguised as these will tend to remain characteristic to the writer in terms of their positioning, form and size (Harrison, 1962), and this study has found strong evidence to support this claim; indeed, 97% of all the disguised samples of extended writing exhibited cross-bar strokes that fell within the range of variation that was

usual for each writer. It was also the case that among those writers whose fore and/or surnames contained cross-bars, a large majority (70%) failed to modify their horizontal cross-strokes and continued to write them in their characteristic way.

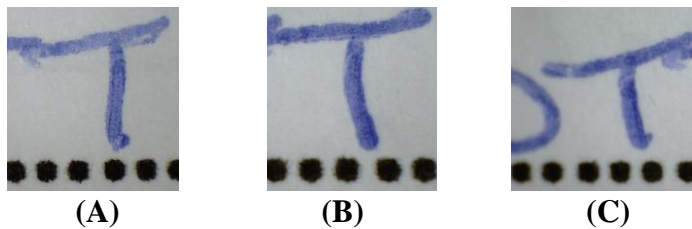


Figure 66: A Natural Upper-Case ‘T’ (A) is Similarly Crossed in Disguise (B & C).

6.2.5.13 Habitual Writing Proportion

The results of this present study are consistent with the theoretical work that suggests that when handwriting is disguised, the proportional relationship between the constituent parts of each letter and between other elements in the writing will remain wholly consistent and characteristic of the disguisers’ natural handwriting (Nickell, 1996; Ellen, 1997; Hayes, 2006).

The data revealed that even when the natural size or slant of writing was modified, the majority of disguisers in both groups would instinctively continue to produce written proportions that fell well within their natural patterns of variation (100% of extended disguise and 87% of signature disguise). It was of no consequence whether the disguised writing was increased or decreased in size since the writers invariably altered the constituent parts of the letters in direct proportion. This was found to be true of all the proportional relationships that have been highlighted in the literature, including those that

exist between upper and lower-case letters, upper and lower extensions, capital letters, and the upper, lower and mid zones of writing.

6.2.5.13.1 *Habitual Size Ratios of Individual Names*

The results of this present study support the recent theoretical claim that the size ratio between the individual names that comprise a disguised signature will typically remain consistent with that of the disguiser's natural signature (Hayes, 2006, p.168). An examination of all the disguised signatures found that the majority (84%) displayed size ratios of individual names that fell within the habitual norms of the writers' genuine signatures.

This is a significant finding since it is the first empirical data that has been reported in relation to this aspect of signature disguise.

6.2.6 Habitual Handprinting

A high majority (60%) of those who employed handprinting as a way to camouflage their natural cursive writing did so using a form of their own natural handprinting throughout. No attempts had been made by the writers to adapt their usual printing in any way, so that it was possible, without difficulty, to identify the individuals concerned when their disguises were compared with suitable exemplars. Moreover, of those who did attempt to use an adapted form of printing for their disguise, the great majority (71%) reverted to habitual methods of printing as their disguise progressed.

OUR LONDON BUSINESS IS GOOD BUT VIEW
MR. D. LLOYD HAS GONE TO SWITZER
HE WILL BE THERE FOR A WEEK AT
TO TURIN AND ROME AND WILL GO
GREECE NOV. 27 OR DEC 2. LET
ADDRESSED: KING JAMES BLVD 351
TUESDAY. DR. L. McQUAD AND RO
'VY EUROPE' TONIGHT. PAID

(A)

OUR LONDON BUSINESS IS GOOD BUT VIEW
MR. D. LLOYD HAS GONE TO SWITZER
FOR GOOD NEWS. HE WILL BE THERE FOR A
ZERMAT ST. AND THEN GOES TO TURIN AND
JOIN CON. PARRY AND ARRIVE AT PITHA
OR DEC 2. LETTERS THERE SHOULD BE AT
KING JAMES BLVD 3580. WE EXPECT CL
TUESDAY. DR. L. McQUAD AND ROBT
ON THE XY EXPRESS TONIGHT.

(B)

Figure 67: Disguised Printing (B) Stays Within the Writer's Natural Variation (A).

6.2.6.1.1 *Summary of Findings: Identifying the Author of Disguised Writing*

Disguised writing will typically incorporate writing features that fall within the limits of the writer's natural variation. In the large majority of disguised samples the rate of occurrence was very high, and for most of these (89%) it was possible to associate the disguised writing with the writer. This suggests that provided that suitable exemplars from a suspected writer are available, it will be possible, more often than not, for the author of a disguised writing to be identified.

6.3 Methods of Tracing

6.3.1 Direct Tracing Methods

Direct methods of tracing were found to be more popular among the participants of this study and accounted for 86% of all the tracings made, and is a finding that is entirely consistent with the claims advanced in the anecdotal and descriptive literature.

Of those who preferred to use a direct technique, it was found that nearly half (49%) resorted to using the window method, which suggests that writers will typically use the most readily accessible method available to them.

The use of an artificial light source, such as a readymade light box to back light the model signature, was used by 27%. The majority of these individuals (92%) ingeniously crafted their own light boxes using materials that were readily to hand; this included the use of Tupperware boxes and light bulbs, and even the backlight from an iPhone.

The remaining 24% of participants used the direct overlay method to accomplish their tracings by which the sheet on which the traced signature was to be received was laid over the model signature and traced directly using with no artificial light source employed.

6.3.2 Indirect Tracing Methods

14% of writers chose to use an indirect method of tracing, and the number of different techniques they employed was limited to only two out of a possible five options available to them. The two methods involved the use of an indented guideline or the implementation of tracing paper to create a copy of the model signature. It was found that those who used these two indirect methods did so in equal numbers (50%).

It is perhaps because carbon paper is much less used today than it was in the past, and is therefore not as ubiquitous as it once was, that the participants made no use of it to create their tracings. Pin prick guidelines were also not made by the writers who, it may be conjectured, were aware of the crude and visible nature of such guidelines which would render them especially susceptible to allegations of forgery.

6.4 Characteristics of Traced Writing

6.4.1 Degenerated Line Quality

A conspicuously poor line quality was observed in every one of the tracings examined for this study. Yet it was not always the case, as Osborn (1929) has suggested, that the participants wholly failed to recognize the importance of a regular, rhythmic ink line, or were unaware of the all the elements that serve to make up the superior ink line that is generally found in natural writing. In fact, when the participants were asked if they could observe any differences between their tracings and the model signature, 87% described

variations that were entirely to do with issues of line quality. All these writers were aware of the differences in pressure patterns, the lack of smoothness in the ink line and disjointed strokes, and all of them stated that their attempts to trace the model signature resulted in a copy that was not as 'spontaneous' or as 'fluent' as the naturally written signature. But simply recognizing faults in the ink line does not, apparently, prevent the writer from involuntarily incorporating them into their forgeries since 100% of the tracings displayed bad or exceptionally bad line quality. It was also the case that writers remained largely ignorant of the finer details of line quality, such as line direction, stroke ends and stroke order, since errors were observed to have occurred in all these elements in the tracings.

6.4.1.1 Speed and Pressure Variation

A comparison between the traced signatures and the model from which they were made revealed marked differences in the speed of execution and in the degree of pressure applied to the pen. The results fully support the findings generated by Kao et al. (1982; 1983) and Leung et al. (1993b) which suggest that tracings will be made more slowly and with heavier pen pressure. The current results also confirm the claim made by Slyter (1995) that '[t]racings are the most slowly made imitations' (p.15).

Every participant produced a tracing that was written at an exceptionally slow speed, while 98% of these writers unwittingly exerted an abnormally heavy pressure on the pen during the tracing process. Both the speed and pressure at which the tracings were made were strikingly at variance with the participants' natural writing. The time taken by each participant to sign their names naturally was between 2 and 5 seconds, with the arithmetic mean and median averages being 4 seconds; it generally took thirty times longer for the

same writers to produce a traced signature. The mean and median averages were 2 minutes with the mode being 3 minutes.

In agreement with the literature, all the tracings had an absence of fine pen lines and line width variation, and 96% displayed unvaryingly dark strokes. A small proportion (2%) applied considerable pressure to their pen, but because they were making their tracing by means of the window method, which involves holding the pen in an unnatural upward position, the ink was not always able to flow properly which meant that the darker ink lines that are associated with heavy pressure were interspersed with strokes that appeared to be much lighter. However, at these moments the writers had exerted an even greater pressure on the paper in an attempt to get the pen to work properly and as a result had pressed so hard as to leave highly visible indentations on the reverse side of the paper and/or deep scores on the top of the paper.

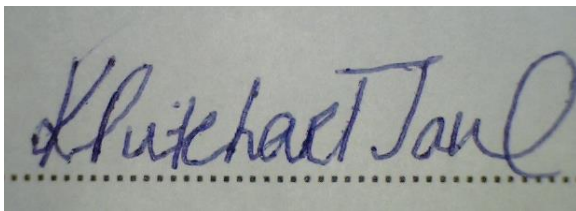


Figure 68: A Traced Signature Displays Heavy Pen Pressure.

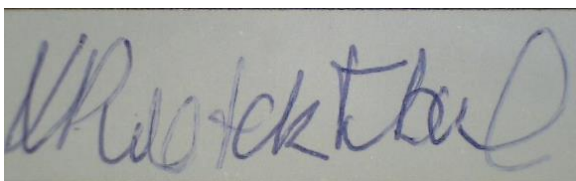


Figure 69: An Abnormal Ink Flow Caused by the Window Method of Tracing.

6.4.1.1.1 *Summary of Findings*

A traced signature will generally differ significantly from the model writing it copies by exhibiting palpable signs of having been produced very slowly and with a consistently heavy pen pressure. This will be indicated by thicker, darker ink lines with no variable shading.

6.4.1.2 **Retouching and Overwriting**

While it is true that present empirical knowledge about this particular characteristic of writing in traced forgery is exceptionally limited, the strong results generated by this research indicate that retouched or overwritten strokes can afford convincing evidence of traced forgery.

Analysis revealed that 77% of the traced signatures contained marks of retouching and/or overwriting, which is a percentage increase of three and a half times that which has been found previously in freehand-simulated signatures.^{cxlviii} The percentage is also a small increase on that found for disguised extended text (18%), and over a twenty-six-fold percentage increase on that found in signature disguise. Even writers who regularly corrected strokes and/or letters in their natural writing generated many more repairs in their tracings; indeed, an analysis of the data showed that there was, on average, a seven-fold increase in the number of repairs made. In one case it was found that the writer had produced a twenty-six-fold increase in the number of instances of overwriting and retouching compared to the number they exhibited in their natural handwriting.

In section 6.2.3.1 it was reported that the majority of retouching and overwriting was performed for the purposes of legibility; in the case of traced forgery, however, it was carried out to correct the numerous errors and/or omissions that were due entirely to the problematic nature of the tracing process, a procedure that necessarily causes elements in the model writing to be obscured. Writers apparently recognized the disjointed nature of their tracings and made attempts to repair the ink line in an effort to impart a more natural appearance to the writing.

On the whole, retouching occurred more commonly than overwriting (58% and 19% respectively). Retouched strokes were typically carried out carefully, with the majority of writers (85%) making concerted efforts to blend new strokes into ones that had previously been written. However, quite the reverse was true for overwritten strokes. It has been said that overwriting ‘carries no sinister implications’ when it is made ‘boldly’ (Vadakumchery, 1985, p.101), and yet this was clearly not the case in the examples of overwriting examined for this study; indeed, 82% of writers who resorted to overwriting did so firmly but carelessly and failed to adhere closely to original written strokes. No attempts were made by these individuals to overwrite neatly, and it was often found that they wrote over the same letter or letters a number of times leaving several overlapping strokes clearly visible.



Figure 70: A Careful Attempt to Blend a Retouched Stroke into the Writing.

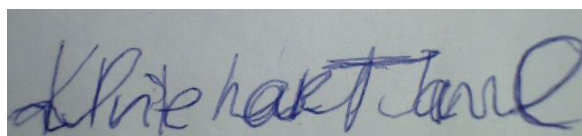


Figure 71: Careless Overwriting in a Traced Forgery.

Information gathered from the respondents indicated that they were so intent on the appearance of the tracing and on their efforts to make the signature look more fluent that they did not fully appreciate the importance of their lack of care. When this evidence is considered in the light of the fact that all those who employed overwriting in their tracings always did so excessively, this suggests that it is not so much the care with which overwriting is performed that is important in a forensic examination of the questioned signature, so much as the frequency of the overwriting that is found.

6.4.1.2.1 *Retouching*

An analysis of the data revealed that retouching was employed by writers to make just eight specific corrections to their tracings. These were as follows:

Reason for Retouching	Frequency of Occurrence (%)
To extend stroke/s	46
To touch-in connecting strokes	39
To touch-in omitted delicate features	36
To perfect strokes	27
To repair the ink line	21
To perfect connecting strokes	15
To add shading to be consistent with the model writing	12
To insert loops	3

Table 6 – Reasons for Retouching in Traced Writing

These amendments generally agree with those that have been described previously in the anecdotal literature; the only exception to this was that some writers tended to touch-in looped formations after the general form or outline of the tracing had been completed. These individuals would, for example, initially draw the connector lines joining the lower-case 'a' to the succeeding lower-case letter 'r'. Only when this had been accomplished would they then superimpose a circle or ellipses on top of the connector line to serve as the main looped body of the lower-case 'a'. This subsequent loop insertion was only carried out by a minority of participants (3%), but it was highly significant that they all accomplished these insertions in exactly the same way.

It has been reported that retouching can sometimes be made with a stroke that moves in the opposite direction to that of the original stroke it seeks to repair or patch and this was found to be the case in over a third (39%) of the retouching that was observed in the traced samples. Although this percentage is somewhat less than that found for the retouching in disguised extended texts (61%), it is a significant increase on that found in simulated signatures (10%), and a clear indication that many of the writers were apparently oblivious to the importance of incorrect line movement as a determining factor of the genuineness or otherwise of writing.

6.4.1.2.1 *Overwriting*

The overwriting of letters or words was carried out for the following six reasons, all of which correspond with those identified in the descriptive literature:

Reason for Overwriting	Frequency of Occurrence (%)
To perfect letter formation	91
To perfect connecting strokes	27
To repair the ink line	18
To extend stroke/s	9
To obscure mistakes	9
To improve the appearance or legibility an entire word	9

Table 7– Reasons for Overwriting in Traced Writing

The proportion of overwriting that was produced with the ink line moving in the opposite direction to the genuine stroke was much larger than that found in the examples of retouching (64%). Once again, it appears that few writers have any clear understanding of line movement. Consequently, any instance of overwriting accomplished with an incorrect line direction should be regarded as suspicious, and multiple instances should be regarded as compelling evidence of forgery.

6.4.1.2.2 *Summary of Findings*

A traced forgery will tend to be repaired more frequently than any other written forgery. Retouching will tend to be applied delicately, whereas overwriting will often be performed carelessly. In both cases repairs or patching will often be made by the writer with the ink line moving in the opposite direction to the original stroke they seek to correct or perfect. It will sometimes be the case that looped formations will be touched-in after the general form or outline of the tracing has been completed.

6.4.1.3 **Hesitation Marks**

An analysis of the data collected suggests that tracings will contain more marks of hesitation than either disguised writing or freehand simulated signatures. The great majority (88%) of writers produced tracings that were extremely hesitant in nature, with the average number of pauses being 3 and the most being 7. In contrast, the writers' normal day to day handwriting was always fluent with no signs of hesitation whatever.

The high proportion observed is nearly double that found in disguised writing and over a third higher than that found in freehand simulations.^{cxlix} It is therefore a finding that reinforces the limited empirical data available, which has reported a similar overall pattern (Leung et al., 1993b), and substantiates the common anecdotal belief that marks of hesitation will increase substantially during the tracing process.

Pen pause manifests itself in the ink line in four distinct ways; 1) an indented ink blot on a written stroke, 2) a firm clear mark beside a stroke, 3) a short jagged appearance to a stroke and 4) an extraneous hairline at the start of a letter.

By far the most common indication that a writer had stopped their pen was the presence of ink deposits or blots on the writing line since this characteristic accounted for 63% of all the hesitation marks observed. In every case the ink blots were pronounced as the writer kept their pen static on the paper while applying pressure to it. In some instances the writers used this pen pressure as a way of pivoting the top sheet of paper away from the bottom sheet in order to view more clearly the model signature underneath. In so doing, they attempted to prevent the top sheet from slipping which, had this happened, would have caused the tracing and its model signature to have become misaligned. Such marks are clearly identifiable when a ball point pen is used since the pivoting action of pen and paper creates a marked circular shape. Moreover, there were always darker marks present around the outside edge of the circular mark which was caused by the ball housing of the pen. The combination of these marks creates a striking and easily recognizable feature (see Figure 72 below).



Figure 72: Pivoting Marks in Traced Forgery.

The data revealed that hesitation was more likely to occur on or around the very first stroke of a traced signature, presumably as the participant prepared themselves for their unusual writing task, and endeavoured to assess the overall shape of the model signature and the general direction of its strokes. Hesitation also occurred at points in the writing that might be considered more challenging: directional changes in the ink line, for example, and/or during angled strokes and narrow turns. Other instances of hesitation were always observed to be in locations that would in natural writing typically be made in one continuous movement, such as during curved or connecting strokes.

The frequency of hesitation was not found to be in any way dependent upon writing skill, although this demonstrable lack of fluency emphasizes the problematic nature of tracing an unfamiliar signature and suggests that no matter how proficient a writer may be, their tracings will, more often than not, be marked by conspicuous and numerous pauses in the ink line.

6.4.1.3.1 *Summary of Findings*

Traced signatures will tend to contain more marks of hesitation than either disguised writing or freehand simulated signatures. Commonly, hesitation marks will be found on the initial stroke of a signature where directional changes take place in the ink line, and in locations that would typically be continuous in natural writing, such as during curved or connecting strokes. Some tracings will exhibit pivot marks that are caused by the writer pausing their pen and exerting pressure upon it in order to pivot the top page to view

the model writing underneath. Such marks are peculiar to traced forgery and tend to be conspicuous.

6.4.1.4 Pen Lift

The data generated by this study validates a general consensus in the literature that pen-lift, like hesitation, is the involuntary result of the unnatural and fragmentary manner by which the typical traced writing is constructed.

A very high majority of the tracings (97%) contained several instances of pen-lift in places that would in genuine writing typically be made in one continuous movement. This is more or less double the overall proportion that was found for disguised writing and for simulations.

The mean occurrence of pen lift for each tracing was found to be 5, a figure greater than the frequency of 2 that was found for the signatures in each of the simulated and disguised categories. There was, however, no evidence to suggest that frequency was in any way dependent upon the particular tracing method employed. The highest number of instances found in a single tracing was 12. Considering the limited amount of writing involved in a tracing, this frequency is significant since it corresponds much more closely to that found in the longer disguised texts (13) and highlights once more the near-impossibility of producing a fluently executed forgery by tracing.

Of the few writers who produced abnormal pen-lift in their natural writing (5%), all increased the number that they typically made by a factor of 3 or 4 in their tracings. Moreover, these writers were entirely consistent, albeit it unintentionally, in their habits of lifting the pen in uncommon places, so that they continued to do so when making their tracings; this, of course, can provide valuable identification evidence for the handwriting examiner.

Among the traced samples it was marginally more common for the pen to have been replaced carelessly on the paper after the pen had been lifted (53%) than it was for the pen to have been replaced carefully (47%). A similar phenomenon has also been observed in disguised writing (see section 6.2.3.4), and also in simulated signatures where the proportion found was much higher at 89% (Lafone, 2005). Nevertheless, in all categories of deviant writing it has been found that pen-lifts will typically be made carelessly, a finding that runs counter to the view traditionally held in the literature that a forger will make strenuous efforts to blend broken strokes delicately to hide the fact that an interruption has been made to what should be a continuous line (Hilton, 1964, p.11).

It was found that there were 11 specific places where the participants lifted their pens when tracing a signature:

Location of Non-Habitual Pen-Lift in Traced Forgeries	Frequency of Occurrence %
Connecting Strokes	21
Curved Strokes	20
Horizontal Strokes	17
Where directional changes in the ink line occur	12
At the completion of every stroke	9
Angled Strokes	5
At the end of every letter before starting the next	5
Mid Letter	5
At the completion of the loop of a letter before drawing its stem	5
Down Strokes	4
Up Strokes	3

Table 8 - Location of Non-Habitual Pen-Lift in Traced Forgeries.

The majority of these locations correspond to those previously identified as suspicious in the literature. The exception to this was that some participants tended to lift the pen after they had completed a distinct circle to serve as the looped body of a letter, such as a lowercase ‘b’, ‘d’, or ‘g’. The pen would subsequently be replaced on the paper to draw a separate stroke to form the stem of the letter. This characteristic was not present in natural writing, and though it was rarely exhibited in the tracings (4%), it perhaps serves to show the immense difficulty of the writers’ endeavour to produce tracings with sufficient momentum to ensure that the forgeries are perceived as writing rather than as constructions of separate and distinct parts.

A recent examination of freehand simulations has concluded that it is not the number of pen-lifts that is significant in a questioned signature, so much as their position within it (Lafone, 2005, p.116); but as far as traced signatures are concerned, the data from this study suggests that the number and position of unnatural pen-lift are of equal importance when determining whether or not a questioned writing is, in fact, a tracing.



Figure 73: Pen-Lift at an Angled Turn.

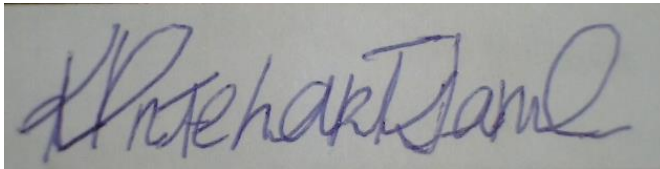


Figure 74: Numerous Pen-Lifts in a Traced Signature.

6.4.1.4.1 *Summary of Findings*

A traced signature will generally exhibit numerous indications in its written line that the pen has been lifted from and returned to the paper. Evidence of unnatural pen-lift can be expected in places where its presence interrupts what tends to be a continuous flow of writing in handwriting that has been genuinely made; commonly, pen-lifts will occur in connecting, curved, and/or horizontal strokes. Numerous and unnatural pen-lifts in questioned writing may be considered a strong indicator that the writing has been traced.

6.4.1.5 Blunt Ends

A blunted appearance to the ends of those strokes that in the model writing had been made more spontaneously was apparent in 100% of the traced signatures. This was a proportion that was higher than that found for disguised writing (73%), but comparable to that found for simulated writing (97%). Indeed, such was the high prevalence of this characteristic among the tracings that it became one of the most detrimental influences upon the quality of the ink line since it clearly revealed the lack of speed and freedom with which the tracings had been made. In a large proportion of these tracings (70%), blunt ends were found on every one of the strokes that comprised them, and even among those tracings that contained some tapering strokes (30%), the frequency of blunted ends was found to be high: the mean average for each tracing being 13.

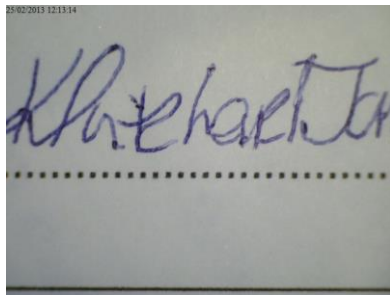


Figure 75: A Traced Signature Exhibiting Blunt Ends on all Strokes.

In those tracings that displayed blunt ends on only some strokes, an analysis of the data revealed that these occurred in the following locations (see Table 9), although there was no evidence to show that any one particular stroke is any more susceptible to becoming blunted than any other.

Location of Blunt Ends in Traced Signatures	Frequency of Occurrence %
Beginning of Down Stroke	9
Beginning of Initial Stroke	9
Beginning of Terminal Stroke:	8
End of Down Stroke	8
Beginning of Up Stroke:	8
End of Up Stroke	8
Beginning of Cross Stroke	8
End of Cross Stroke	7
Beginning of Curved Strokes	7
End of Curved Strokes	7
Beginning of Flourish Stroke	7
End of Flourish	7
Connecting Strokes	7

Table 9: Blunt End Locations in Traced Forgeries

It was found to be more usual for blunt ends to assume a clubbed appearance at the end of a stroke (87%) with only a few (13%) exhibiting a fishtail form (see Figure 76 and Figure 77).

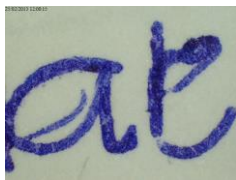


Figure 76: Blunt Ends – Fishtail.



Figure 77: Blunt Ends – Clubbed.

6.4.1.5.1 *Summary of Findings*

A high prevalence of strokes possessing blunted ends is to be expected in a traced signature. Often these will assume a clubbed appearance, although a fishtail form may sometimes be encountered. Blunt ends will often occur on every stroke in the signature and is a very strong indicator of traced forgery.

6.4.1.6 Tremor

None of the respondents displayed tremulous strokes in their natural writing; nevertheless, a marked deterioration in the appearance of the ink line caused by the presence of tremor was apparent in 93% of the traced forgeries. This is a figure that closely corresponds to previous empirical research (Leung et al., 1993b) and supports the view widely accepted in the literature that the occurrence of tremor is a defining characteristic of traced forgery. The proportion of tracings containing tremor compares favourably to that found for freehand simulations (91%), but is over eleven times larger than the percentage found overall for disguised writing (8%).

Conflicting opinions exist among handwriting experts as to whether it will be more usual to find the tremulous strokes in a tracing to be subtle and unobtrusive in nature, or whether they will tend to be highly conspicuous (Robertson, 1991; Cardaciotto, 1992; Hayes, 2006). In fact, both types of tremor were found in the tracings examined for this study, although it was far more common for samples to evidence gross tremor (71%) than fine tremor (29%), a finding that corresponds with that found for disguised writing.^{cl}

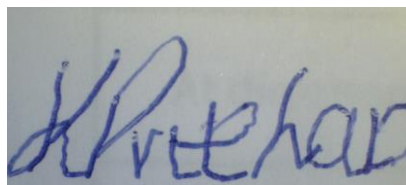
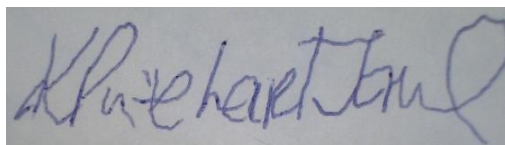


Figure 78: Traced Signatures Exhibiting Gross Tremor.

The strokes in which tremor was present are generally consistent with those that have been previously reported for the categories of simulation (Lafone, 2005, p.114) and disguise.^{ci} The production of a smooth ink line in the curved and down strokes appeared to be especially problematic for the participants of this study, just as it had been for the writers of the other two groups, since it was in these strokes that most instances of tremor were found. The other locations in the tracings that were observed to have tremor are detailed in Table 10 below:

Location of Unnatural Tremor	Frequency of Occurrence %
Curved Strokes	41
Down Strokes	28
Connecting Strokes	10
Horizontal Strokes	9
Up strokes	7
Initial strokes	2
Terminal strokes	2
Angled Strokes	1

Table 10: Location of Unnatural Tremor in Tracings

The strong results that have emerged from this study with respect to the frequency and location of tremor in traced forgeries reaffirm the previous empirical findings made by Leung et al., 1993b, whilst also being highly consistent with those achieved in a recent examination of freehand simulated signatures (Lafone, 2005).

6.4.1.6.1 *Summary of Findings*

Traced forgeries will generally exhibit a marked deterioration in the writing line in the form of conspicuous oscillations, or tremor; these will be visible with or without the benefit of magnification. Tremor will commonly occur in curving strokes and down strokes.

6.4.1.7 **Acute Angles**

An analysis of the data indicates that traced forgery, like simulated forgery, is more susceptible to frequent shifts in the movement of the writing line which causes curved strokes to become angular in appearance.

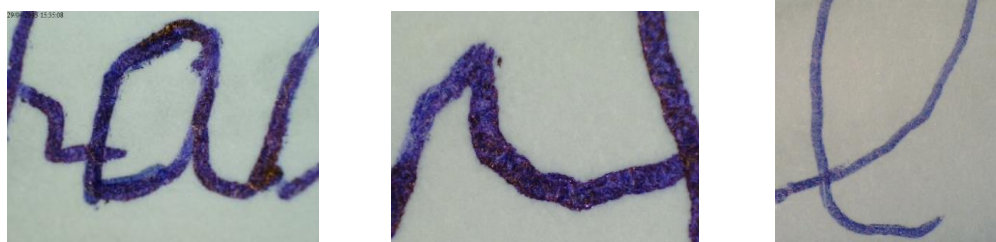


Figure 79: Acute Angles Caused by the Tracing Process.

An overwhelming majority (98%) of the tracings exhibited acute angles in the ink line, a finding similar to that seen in simulated signatures (97%. Lafone, 2005). The present results provide the first empirical evidence of a relationship between the tracing process and the occurrence of abrupt directional changes in the written line and serves to provide strong support for the anecdotal claims that have been made previously in respect of this characteristic.^{clii}

6.4.1.7.1 *Summary of Findings*

It is to be expected that a traced signature will exhibit abrupt shifts in the ink line that will impart a definite angled appearance to curved strokes that in natural writing would tend to be written smoothly.

6.4.1.8 **Irregular Line Edges**

As was mentioned in section 4.2.1.8, there has been only one reference to this characteristic in the anecdotal literature (Quirke, 1930) and none at all in the body of experimental information. This is remarkable in that the results obtained from this study provide convincing evidence that traced writing will exhibit irregular edges on either side of many, if not all of its strokes.

Overall, 93% of the tracings possessed ragged edged strokes: two thirds displayed this feature throughout, while the remaining third did so intermittently.

There is, however, a significant difference between the serrated appearance of this feature that has been described by Quirke in 1930, and the somewhat more rounded indentations that were observed in this current study. The disparity is almost certainly due to the specific types of writing instrument used to make the tracings. At the time Quirke was writing, nib pens were the writing instrument in common use, but the tracings made for this study were all made with the ballpoint pen. The indentations that are made by this type of modern pen are readily identifiable since they take the shape of the metal ball that is housed in the body of the pen for the purposes of delivering ink to the paper. When a ballpoint is slowed, it will frequently deposit ink unevenly to the written line; since the pen will necessarily travel slowly over the model writing during the tracing process, the resulting ink deposits continually take the impression of the metal ball, so that a series of rounded indentations are created at the outer edge of either side of the ink line (see Figure 80).

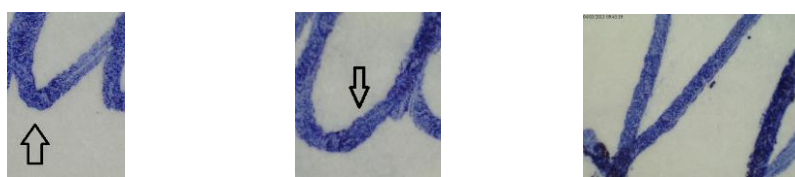


Figure 80: Ragged Line Edges with Rounded Indentations.

Notwithstanding the difference in appearance occasioned by the type of pen employed, the solid findings reported here strongly suggest that the presence of ragged line edges cannot be dismissed as an antiquated characteristic of traced forgery, but rather is one that will tend to appear, no matter what pen is used.

It was significant that all of the tracings that exhibited intermittent indentations did so in only four locations, and these are detailed in Table 11 below:

Location of Ragged Edged Strokes	Frequency of Occurrence %
Curved Strokes	60
Down Strokes	20
Flourishes	10
Horizontal Strokes	10

Table 11: Location of Ragged Edged Strokes in Traced Forgeries

It is clear from the information in Table 11 that this characteristic of traced writing is chiefly found in curved strokes. Throughout this study it has been found that curves are particularly problematic for the forger to achieve; this is probably because their production requires more cognitive resources than are required for some other strokes, so that the forger inevitably slows their pen at such moments in the writing, not realising the negative implications that this has for the written line.

6.4.1.8.1 *Summary of Findings*

In the process of tracing, the smooth outer edges of a written stroke, a feature generally associated with unrestrained natural writing, will tend to become irregular or ragged in appearance. Ragged line edges may be rounded or serrated in appearance depending on the pen that is used to make the tracing.

Any stroke may be affected in this way, but irregular line edges will most commonly be observed in curved strokes.

6.4.2 Conclusion: Degenerated Line Quality in Traced Forgery

It is to be expected that a traced signature will invariably exhibit a very poor line quality. The smooth ink line that is generally characteristic of a genuine signature will become noticeably uneven as it is affected by numerous instances of some or all of the features that are indicative of a writing that has been made slowly and hesitantly. Degenerated line quality may be regarded as a chief determinant of traced forgery.

6.4.3 Visible Guidelines

Solid results were found with which to support the dominant view in the literature that when guidelines have been used to make a tracing, compelling evidence of this fact will always be present in the writing.

An examination of the tracings that had been created with a guideline revealed that in every one of them the entire guideline or some part of it remained uncovered. As has been reported in section 4.2.2, there were only two types of guideline that were employed by the participants in this study: indented guidelines and those made by tracing paper. There was, however, no evidence to indicate that one type of guideline was any more susceptible to exposure than the other.

Where an entire guideline was visible, it was always observed to run alongside the ink line, creating the impression of a double-track. This was the case even when tracing paper had been employed; the graphite outline that occurred as a result of the tracing paper process created a ghosting impression that surrounded the final inked in signature. Notably, no attempts were made by these participants to erase their graphite outline: a finding that is entirely in line with observations made by Harrison (1964).

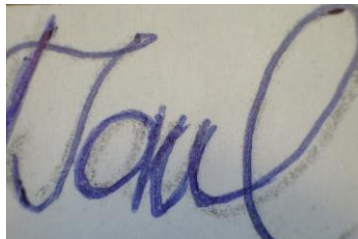


Figure 81: The Presence of Graphite Guidelines in a Traced Signature

When only part of the guideline was visible, this was found to have occurred in five locations, detailed in Table 12 below:

Locations at which Guidelines Become Visible	Frequency of Occurrence %
Curved Strokes	30
Terminal Strokes	30
Beginning of Down Strokes	20
Angles	10
Initial Strokes	10

Table 12: Evidence of Traced Guidelines.

With the exception of the beginning of a down stroke, all the strokes mentioned in the table above have previously been identified as those that are particularly difficult for the forger's pen to adhere to when following a guideline. As regards the down stroke, it was found that in every case, the forger began retracing the guideline fractionally too low so that the top of the guideline always remained uncovered.

Whether the guidelines were mere depressions in the paper or graphite outlines, it was significant that all were clearly visible with or without the aid of magnification or the use of an ESDA machine. In a real case situation, therefore, the forensic handwriting examiner would have had no difficulty in exposing the signatures as traced forgeries.

6.4.3.1.1 *Summary of Findings*

When guidelines have been used to create a traced forgery, there will invariably be evidence present in the tracing that can establish this fact, regardless of the type of guideline employed. Entire guidelines will sometimes be observed to run alongside the ink line for the duration of the signature, but where only a partial guideline is observable, this will commonly occur on curved strokes, terminal strokes or at the very beginning of down strokes. Guidelines may also be observed on angled strokes and initial strokes, but much less frequently. Guidelines will typically be visible with or without the aid of magnification.

6.4.4 Inconsistent Superimposition

Entirely in line with the findings of Leung et al (1993b) and with the expectation that a traced writing will exhibit a high degree of superimposability with its model, the data showed that 50% or more of the component strokes of the majority of the traced samples (86%) overlapped those of the model writing.

There was, however, no direct support for the claim that traced semicircles will exhibit a higher superimposability than the tracings of zig-zag lines (Leung et al., p.418). In fact, quite the opposite was found. In accord with many of the findings that have been reported throughout this study, it was the curved strokes that appeared to be harder for the participants to trace as only 8% of the tracings contained curved strokes that exhibited a closer coincidence to the model writing than its zig-zag formations. Since, therefore, the great majority of tracings (93%) possessed zig-zag strokes with a higher degree of correspondence to those in the model writing, it may be conjectured that it is, in fact, these strokes that are simpler for the forger to trace.

It was interesting to find that there were no examples of exact duplication among the traced samples examined for this study, which supports the view that it is unlikely that the tracing of a signature can ever be a microscopically exact facsimile of its model writing (Osborn, 1929, p.346). Indeed, 14% of the tracings were assessed as having poor or extremely poor superimposition; however, these tracings were so badly executed that the likelihood of their ever being acknowledged as natural writing is highly unlikely.

The findings strongly reaffirm Osborn's conclusion that evidence of suspicious similarity between signatures should not alone be used as proof of traced forgery, but can provide useful corroborative evidence when interpreted in the light of other findings that point to the tracing process (p.349).

6.4.4.1.1 *Summary of Findings*

It is to be expected that most traced forgeries will show a close correspondence with the strokes of its model writing, but they will never be an exact duplication. In particular, curved strokes will reveal less coincidence with those in the model writing.

6.4.5 **Omission of Detail**

An overwhelming majority of the traced samples (98%) omitted some of the fine detail or inconspicuous elements that were integral to the model writing. Most of the participants stated that they had made the omissions simply because they had been unable to see the model writing clearly underneath the top sheet of paper on which the tracing was made; but some writers had apparently been concentrating so hard on the overall form and outline of their tracing that they had failed to include elements such as the dot of a lower-case 'i'. Nearly all the writers failed to reproduce in their tracings the stroke sequences (96%) and/or hairline strokes (94%) that were apparent in the model writing, while a large number (85%) also failed to include all the fine detail of the model's letter forms.

It was not only the fine detail of the model writing, however, that was lost during the process of tracing as it was sometimes the case that clearly discernible features in the model writing were omitted from the subsequent tracing. Indeed, 16% of the writers were found to have neglected many of the model writing's conspicuous looped formations, while 1% of the writers even failed to include some or all of the genuine writing's highly visible connecting strokes.

Table 13 lists the occurrence frequency of the omissions that were observed in the traced samples:

Elements of the Model Writing Omitted from the Subsequent Tracing	Frequency of Occurrence %
Omission of Stroke Sequences	26
Omission of Hairline Strokes	25
Omission of Letter Form Detail	23
Omission of 'i' Dots	20
Omission of Loops	5
Omission of Connecting Strokes	1

Table 13: Omission of Detail in Traced Writing

6.4.5.1.1 *Summary of Findings*

A traced writing will typically contain less detail than the model writing it copies and will typically omit more detail than will be observed in a simulated signature. The fine detail and inconspicuous elements that are integral to the model writing, such as stroke sequences, hairline strokes, letter form detail and 'i' dots, will commonly be omitted from the tracing. Looped formations and/or connecting strokes may also be excluded, but far less frequently.

6.4.6 Misinterpretation of Letter Forms

In an examination of simulated signatures it was concluded that when forgers did not know the name of the signatory whose writing they copied, they would often mistake one letter for another (Lafone, 2005, p.134); this same phenomenon also occurred in just over half the disguised signatures studied for this current research. Misinterpretation of form was also observed in the traced signatures, but in a considerably larger proportion (96%). Significantly, 10% of these writers made letter substitutions that were written in their natural handwriting.

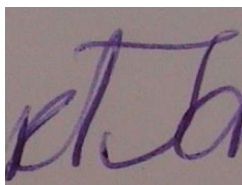
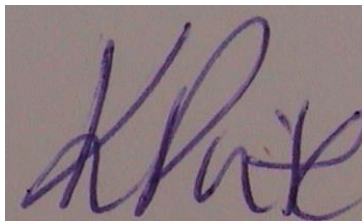
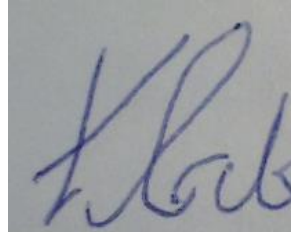


Figure 82: Letters 'd' and 'J' in the Genuine Writing [A] becomes 'D' in the Tracing [B].

In some instances the participants, apparently unable to discern some letters in the model signature, produced a series of disjointed strokes with little attempt to form clearly defined letters.



[A]



[B]

Figure 83: Connected Strokes in the Genuine Writing [A] Become Disjointed in the Tracing [B].

The participants were given every opportunity to request the name of the signatory, but it was significant that no one, in fact, did so. This suggests that the writers concentrated more upon the shape of the model writing than they did on the detail of its content, and further suggests that an unavoidable effect of obscuring the model signature by the tracing sheet will cause a misinterpretation of letter forms to occur more frequently than in simulations. This characteristic was observed in nearly twice the numbers of tracings than in freehand simulations and clearly indicates that this is a feature that will generally be encountered in traced writing, particularly when the model writing is lengthy, and/or contains letters that are not clearly discernible.

6.4.6.1.1 *Summary of Findings*

During the process of tracing, the forger will frequently misinterpret letter forms that occur in the model writing and will incorporate erroneous characters in their tracing. Sometimes, an incorrect character will be formed in the forger's natural hand. Owing to the nature of the tracing process, any tracing may exhibit misinterpreted letter forms, but commonly, it will occur when the model writing is lengthy and contains characters that are not clearly identifiable.

6.4.7 Incorrect Line Direction

Written strokes that had been traced with the pen moving in the wrong direction to those appearing in the model writing were observed in almost all the traced signature samples (98%).

There are several strokes that are identified in the literature as being more likely than others of being traced in the wrong direction: clockwise and/or anticlockwise loops, stroke ends and cross-bars (Metzler, 1981; Leung et al., 1993b; Levinson, 2002). Certainly, all these strokes were found to be source of error in the traced samples examined for this study; stroke ends were often found to have curves that moved in the opposite direction to those in the model writing, and many of the tracings incorporated loops that were traced with a contrary circular movement to that of the natural forms they copied, although the data showed that clockwise loops were marginally more likely to be reproduced incorrectly than anticlockwise loops. Faulty cross-bars were also observed to have been traced with the ink

line moving in the wrong direction, but the frequency of this characteristic was somewhat less than for those mentioned above (see Table 14).

These findings notwithstanding, the results from this study suggest that there are additional strokes that are susceptible of being made with an incorrect line movement and that these should also be carefully examined in writing that is suspected of having been traced. In particular, it was often observed that the line movement at the end of a stroke would be reproduced in the wrong direction: for example, if the end of the stroke moved abruptly to the right, the tracing would move it to the left. Up strokes and down strokes were also affected, although the strokes that moved in an upward direction were somewhat more prone to this fault than those that moved downwards. Table 14 details the frequency of occurrence of incorrect line direction in these strokes as well as in those others where this characteristic was observed.

Incorrect Line Direction	Frequency of Occurrence %
Stroke Ends	18
Up Strokes	17
Down Strokes	16
Clockwise Loops	13
Anticlockwise Loops	10
Curves	7
Cross-bars	5
Directional Changes in the Line	5
Angles	4
Connectors	4
Flourishes	1

Table 14: Incorrect Line Direction

Follow-up interviews with the participants confirmed what the results from this present study had already indicated: namely, that the typical writer is largely ignorant of the general movement of the ink line in written texts and unaware of its importance in handwriting analysis. Those volunteers that were cognizant of its significance acknowledged that mistakes often occurred because the line direction of the model writing was obscured by the top sheet of paper that was used to make the subsequent tracing. In addition, some writers admitted to being so focussed on reproducing the outline of the model writing sufficiently well, that they failed to examine the genuine writing beforehand to determine the proper direction of the strokes

6.4.7.1.1 *Summary of Findings*

Traced writing will typically contain strokes that move in the wrong or opposite direction to that of the corresponding strokes contained within the model writing. Commonly, this characteristic will occur in stroke ends, in the up and down strokes, and in the clockwise and anticlockwise loops. The presence of strokes that move in the wrong direction to the genuine writing should be regarded as strongly indicative of traced forgery.

6.4.8 Over and Under Extension of Strokes

The tendency for tracers to produce longer stroke lengths than those in the model writing has been discussed in the anecdotal literature (Osborn, 1929; Hilton, 1939), and it was certainly the case that many of the traced samples made for this study displayed strokes

that extended further than the natural strokes they copied; but conversely, some sample writing contained stroke lengths that were shorter than those in the model writing.

A very high majority of the tracings (95%) exhibited over and/or under extended strokes. Of these, 57% displayed over extended strokes only, 9% displayed under extended strokes only, while 34% of the tracings displayed both.

Hilton (1939) and Osborn (1929) have suggested that it will be the vertical strokes of a traced forgery that will often continue too far below the baseline. This was found to be true in the majority of the overextended strokes observed, although it was also found that many of the traced vertical strokes extended too high above the mid-zone of the writing when compared with the natural writing they copied. Only two other strokes contained errors in length in the traced samples: cross-bars and the final flourish of the signature which was frequently found to continue too far below the baseline.

The frequency of those traced strokes that commonly exceeded the corresponding strokes in the model writing can be found in Table 15 below.

Over Extended Strokes	Frequency of Occurrence %
Vertical Strokes Extend Too Far Below Baseline	35
Flourishes Extend Too Far	24
Vertical Strokes Extend too High Above Mid Zone	23
Cross-bars Extend Too Far	18

Table 15: Over Extended Strokes in Traced Signatures

The strokes that were found to have been under extended in the tracings were limited to only three: cross-bars, vertical strokes and flourishes, and the frequency with which these strokes were made can be seen in Table 16 below.

Under Extended Strokes	Frequency of Occurrence %
Cross-Bars in the Tracing Decrease in Length in Comparison to the Model Writing	48
Vertical Strokes do not Extend Far Enough towards or Below the Baseline	35
Flourishes do not Extend Far Enough Below the Baseline	17

Table 16: Under Extended Strokes in Traced Signatures

The findings again reveal the particular challenge that is faced by forgers when they attempt to trace another's handwriting: namely, that the model writing is necessarily obscured by the tracing medium to a greater or lesser extent. The struggle to discern the model writing beneath the top tracing sheet sufficiently well to be able to copy it with precision makes it extremely hard for the forger to commence or terminate individual strokes at exactly the same position as those in model writing; consequently, a certain amount of guess work will be made by the forger in his or her assessment of where the pen should start or stop.

6.4.8.1.1 *Summary of Findings*

A proliferation of strokes of varying lengths will often be apparent in a traced forgery. The presence of irregular stroke lengths in a questioned writing will not on its own proclaim the writing to be traced, but in conjunction with other corroborative evidence, will serve as a strong indication that tracing has occurred.

6.4.9 **Inconsistent Alignment**

The positioning of nearly every tracing was found to be inconsistent with the genuine model writing. The overall alignment of the writing relative to the printed line or printed box was incorrect in 96% of the samples. Of these, the large majority (83%) tended to be positioned too far to the right and too high or low to the printed line when compared with the original writing. A much smaller proportion of the tracings (11%) were begun too far to the right only, while the remainder (6%) were positioned too far to the left.

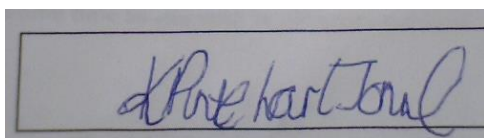


Figure 84: A Tracing Positioned too Far to the Right.

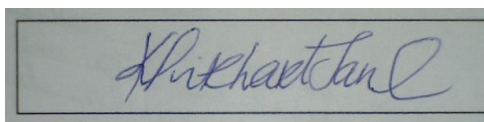


Figure 85: A Tracing Positioned too Far to the Right & too High to the Baseline.

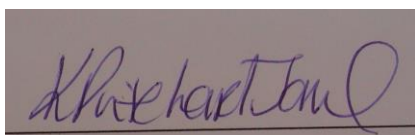


Figure 86: Model Signature.

Individual whole letters that abruptly shifted above or below the overall baseline of the writing were found in 69% of the traced samples that displayed incorrect alignment. The cause of the majority of these errors was confirmed by the participants as having been due to paper slippage which occurred as they attempted to view the genuine writing underneath the tracing paper; the remaining mistakes were simply caused by a momentary loss of pen control during the tracing process.

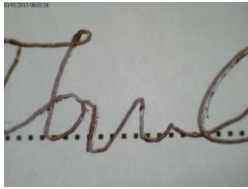


Figure 87: Letter Shift in Tracing.

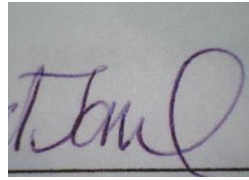


Figure 88: Letter Placement in Model.

It is significant that only 4% of the participants were able to produce a tracing that was reasonably consistent with the genuine writing in terms of its positioning on the page and its overall baseline alignment. The large number of failures that were found in this regard among the traced samples serves to reinforce the opinion that accurate positioning is not an element of genuine writing that tracers tend to be aware of.

6.4.9.1.1 *Summary of Findings*

A questioned signature that departs significantly from the known habits of the genuine signatory in terms of positioning and baseline alignment is likely to be a forgery; moreover, where individual letters are observed to have shifted abruptly in the writing, there is a high likelihood that the writing has been traced.

6.4.10 Extraneous Marks

The presence of superfluous marks in traced forgeries is a characteristic that has been discussed only briefly in the literature (Harrison, 1966), and only in so far as they relate to the carbon or graphite sheets that may have been used to make the tracings;^{cliii} but in this present study only a minority of tracings (3%) exhibited extraneous marks made in this way since very few writers chose to use a graphite sheet to create their forgery, and none at all used carbon paper. Nonetheless, it was true that of the few who did use graphite paper, all their tracings displayed graphite smears, and no attempts were made by these individuals to remove such marks.

Over half (57%) the traced samples displayed various types of mark in and around the writing, including those that were deposited by graphite sheets. Many of these marks (31%) were observed to take the form of general smudges which were due to the tracer's hand having rubbed over writing that had already been completed. It may be conjectured that these marks occurred as a direct result of the tracing process which necessarily forces the writer to utilize unaccustomed writing movements as they over trace unfamiliar writing, and that this inevitably impedes the control the writer has over the positioning of their hands as they write.

Nevertheless, by far the largest proportion of the marks observed (66%) were fine thin lines that appeared to have been caused as the writer lifted their pen and kept it hovering over the writing while they deliberated their next move. In failing to lift the pen high enough off the paper, the pen nib frequently made gentle contact with the paper causing fine hairline strokes to appear haphazardly in the traced writing. More usually, this occurred in close

proximity to the writing, but it was also the case that the fine lines would bisect strokes or whole letters.



Figure 89: Extraneous Marks in Traced Writing.

Of all the extraneous marks that were observed in the traced samples, exactly two-thirds of them were fine hairlines, yet this is a characteristic of traced forgery that has not, until now, been identified in the literature. Even so, the frequency with which these lines occurred in the traced samples examined for this study indicates that their presence in a questioned signature should be viewed as highly suspicious.

6.4.10.1.1 *Summary of Findings*

Traced signatures will frequently display superfluous marks. Smudges may be present where the forger's hand has rubbed over writing that has already been completed, and/or graphite smears may be observed when a graphite sheet has been used to create the tracing. More commonly, fine hairlines will be found in close proximity to the writing, or will be observed to bisect individual strokes and/or letters.

6.4.11 Discrepancies of Size

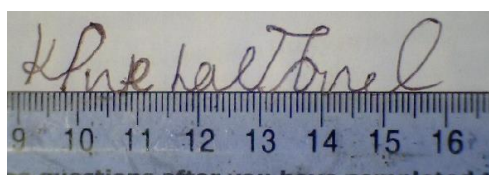
The overall vertical height and overall horizontal width of the traced signatures were measured and compared with the genuine model signature.

Discrepancies in size were found in 60% of the traced signatures. Leung et al. (1993b) have indicated that the height to width ratio in a traced writing is more likely to increase than decrease, and this is confirmed by the data generated by this study which shows that there were no instances among the traced samples of a decrease in height to width ratio from that of the model signature.

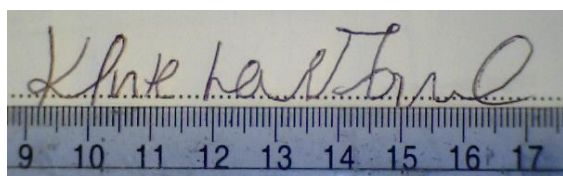
Undoubtedly, the most common shift in size found among the traced samples compared to the model writing was an increase in overall horizontal width. This occurred in 40% of the tracings, although this figure becomes more significant when it is combined with the 20% of traced signatures that were found to have increased both in width and height. The resulting figure of 60% reveals that when a traced writing inadvertently becomes a different size to its model writing, it will typically increase in horizontal width.

Metzler (1981) has claimed that certain groups of consecutive letters which are consistently sized in the model writing will exhibit a sudden diminishing of size in the subsequent tracing. This was not found to be the case in any of the consecutive letters occurring in the traced samples examined for this research. Nevertheless, an abrupt diminishing of occasional looped formations occurred in 20% of the tracings, although this phenomenon was not found among sequential letters.

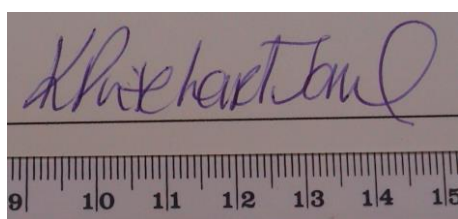
The discrepancy in size observed between the traced samples and the genuine writing was highly conspicuous. As constant pauses were made by the writers during the tracing process, presumably in order to check the accuracy of their work against the model writing, the spacing of the letters became haphazard and inconsistent which contributed to a wholly unnatural appearance that ultimately failed to achieve the authentic appearance that the tracer must have initially desired.



Traced Signature (A)



Traced Signature (B)



Traced Signature (C).

Figure 90: Tracings (A & B) Differ in Horizontal Width from Model Signature (C).

It had been conjectured that conspicuous sizing errors were due to the paper slippage that often occurs during the tracing process and this explanation was confirmed by the participants in their follow-up interviews. Nevertheless, it does seem extraordinary that a tracing can be produced with a conspicuously different size to its model, and, indeed, it had

been expected at the outset of this research that the tracing of another person's writing would result unfailingly in a copy that possessed more or less identical dimensions to that of its model writing. However, the results from this study demonstrate that a tracing will often differ in size from its model.

6.4.11.1.1 *Summary of Findings*

It will frequently be found that a traced signature will differ in size from the model writing it copies and that disparities of size will tend to occur in the overall horizontal length. Moreover, inconsistencies in size will lead to an appearance that is distinctly unnatural and one that can alert the examiner to the possibility of forgery.

6.4.12 **Discrepancies of Slant**

Fully in line with expectations, an examination of the traced samples revealed that the majority (70%) replicated the slant and tilt of their model writing reasonably well (although this means, of course, that just under a third of the samples (30%) failed to follow correctly the direction of slant in the genuine writing).

Slant replication of the down strokes appeared to create the greatest difficulty for the writers. This was surprising as it had been thought that the slope of the curved strokes might have been more difficult to reproduce, particularly in light of the difficulties that

were generally experienced by the participants during the course of this experiment when attempting to trace curved strokes accurately.

Among the tracings that displayed discrepancies of slant, 48% exhibited errors in the slant of three specific lower-case letters: 'e', 'i' and 't'. These particular letters have also been identified by Leung et al. (1993b) as being 'more difficult' for writers to trace accurately in terms of slant and tilt, although in this study it was the capital forms of these letters that appeared to be more problematic for the writers.

It has been said that slant deviation will tend to occur in those strokes that are very lightly written in the model writing (Osborn, 1929); but this was not found to be true in the samples examined here. The strokes that displayed incorrect slant in the tracings had all been written firmly and clearly in the model writing.

It is hard to determine the precise reasons why some writers were unable to replicate another's slant in their tracings, particularly as none of those involved were able to offer any explanation for their lack of success in this regard, and seemed somewhat surprised by it. There was no evidence to suggest that the slant deviation observed had been caused by a return to habitual writing modes on the part of the volunteers, so it is conjectured that it was in some way due to the tracing process itself; indeed, constant referrals to the genuine signature beneath the tracing may have caused a misalignment of the top and bottom sheets of paper so that it would have been a near impossibility for the tracer to follow the correct direction of slant precisely.

Equally, a lack of awareness on the part of the participants of the subtleties of the writing slope in the model signature may have been contributory cause of slant deviation in the tracing. Leung et al. (1993b) have hypothesized that poorer slant accuracy will be achieved when the slant of letters in the model writing is ‘small in magnitude’ (p.415)^{cliv} and it was certainly the case that the model writing used in this study had a small forward angle of inclination relative to the baseline. This caused the writing to be more upright, which made the slant a much less conspicuous feature of the model signature than it would have been had it leaned further to the left or the right. Because the writing was unobtrusive, this may have caused the participants to have concentrated on perfecting the accuracy of other more conspicuous features in the writing to the detriment of the inclination of slant in the tracing.

Comparative to some other tracing characteristics, the proportion of traced signatures that contained inaccurate slant was relatively small. It is not, therefore, suggested that the presence of slant deviation on its own will characterise a writing that has been traced, but it can, nonetheless, serve as a strong indication of forgery if it is observed in a questioned signature that has been tendered as genuine.

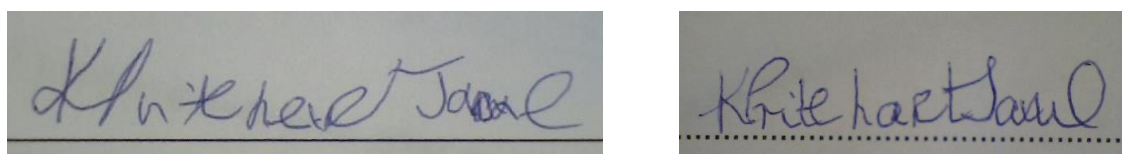


Figure 91: Slant Deviation in Traced Signatures.

6.4.12.1.1 *Summary of Findings*

A traced forgery will sometimes fail to follow the direction of writing slant exhibited in the model. Slant deviation will most commonly occur in the down strokes and particularly in the lower-case letters ‘i’ and ‘t’. The slant and tilt of the letter ‘e’ may also be incorrect. Slant deviation will not on its own proclaim the writing to be traced, but in conjunction with other corroborative evidence, it can serve as a strong indicator that the writing has been unnaturally made.

6.4.13 The Inclusion of Individual Characteristics in Traced Writing

Traced writings are often described in the literature as drawings of another person’s writing (Conway, 1959, p.22; Nickell, 1996, p.60), and as such are not expected to contain any elements of the writer’s unique, natural writing habits that are produced when writing is made spontaneously. Nevertheless, an analysis of the data generated by this study revealed that there were a small number of participants (9%) who did unwittingly introduce such elements into their tracings.

Two types of individual characteristic were observed: idiosyncratic pen-lift and the intermittent inclusion of letter forms that had been written in the tracer’s natural hand.^{clv} The natural features were clearly discernible in the traced writing, but the frequency with which they occurred was very small, being on average 2 occurrences in any one tracing, and cannot, therefore, be deemed sufficient evidence on which to base a conclusion of identity.

6.4.13.1.1 *Summary of Findings*

Traced signatures will only rarely contain the individual characteristics of their writer, but when they do, these will typically involve idiosyncratic pen lift and the incorporation of habitual letter forms. Such characteristics will not, however, appear in sufficient number to enable the tracing to be reliably linked with the tracer.

PART V

Summary and Discussion

7 SUMMARY AND DISCUSSION

‘The time is ripe,’ Saks and Koehler (2005) assert, for the traditional forensic sciences ‘to question the core assumptions’ on which their disciplines rest, and to replace these with ‘a more defensible empirical and probabilistic foundation’ (pp.892 and 895).

The primary objective of this current research was to test some of the basic tenets that are central to the field of handwriting analysis to establish if it was possible to obtain quantitative evidence that could be used to establish a systematic and comprehensive classification of the distinctive and intrinsic features of voluntarily made disguised or traced handwriting, and to determine the extent to which it was possible to identify the author of such writing.

The theoretical foundations upon which this study has been built were formed on the basis of observations that were drawn from the experimental and anecdotal literature, but an attempt has been made to step beyond the limits of mere descriptive analysis of the characteristics that may expose deviant writing by means of objective testing, measurement and comparison of known samples of disguised, traced and natural writing.

The study was designed to formalize, as far as practicable, the procedure of investigation so as to maximise objectivity and minimise subjectivity. Nevertheless, it must be acknowledged that there are elements within handwriting that cannot yet be entirely quantifiably assessed, such as its legibility and/or letter shape, although it may be that developing computerised technologies, such as D-Scribe, WANDA and FLASH ID, will enable such evaluations to be made reliably in the future (Franke, 2013; Sargur, 2013; Schulte-Austum, 2013; Walch & Gantz, 2013).

A degree of subjectivity was also unavoidable in certain assessments that were made during this study: determining where a cursive stroke begins or ends, for instance, is necessarily dependent upon the subjective interpretation of the examiner, and the validity of their conclusion is reliant upon their past experience, theoretical knowledge, skill of observation and their competence in interpreting what they see. Consequently some degree of subjectivity will inevitably play a role in the examiner's judgment of 'when variations are explainable and when they indicate real difference' (Inman and Rudin, 2001, p.228).

The ineluctability of subjective opinion in the analysis of handwriting appears to conflict with the notion of impartial scientific evidence and raises the question of whether handwriting evidence can ever be accepted as reliable. Indeed, should all forensic evidence be rejected if it can be demonstrated that subjective elements have informed its conclusions? Most commentators think not because this would tend to exclude all forensic analyses, including such well-established and respected disciplines as DNA profiling, because, like any human endeavour, there will inevitably be 'a subjective component, in which the analyst decides whether or not to interpret the evidence and the thresholds to institute during the evaluation' (Budowle et al., 2006).

The North American Federal Rules of Evidence also support the view that a degree of subjective opinion will always tend to be involved in forensic evidence. Rule 702, which governs the presentation of evidence by expert witnesses in both civil and criminal cases under the United States federal court system, cited *Kumho Tire Co v. Carmichael*²⁷ when it stated that ‘no one denies that an expert might draw a conclusion from a set of observations based on extensive and specialized experience;’ however, a proviso was added later that such a conclusion is acceptable only so long as the principles and methods of the specialized knowledge ‘are reliably employed to the facts of the case’ (U.S. Advisory Committee on the Federal Rules of Evidence, 1999, p.2).^{clvi}

Overcoming subjectivity to the greatest possible extent is, then, one of the most important tasks confronting those involved in the field of forensic examination of handwriting today, for it is only by reducing subjectivity that we can reduce the possibility of error. This study, then, is offered as a contribution to the process of moving the profession towards more objective testing and standardization. The methods for obtaining and analysing data were consistent with and have built upon those that have been used in prior research (Lafone, 2005), and these have been found to be reliable and replicable. The study has demonstrated that many of the concepts and beliefs inherent to the discipline of handwriting analysis are susceptible to empirical testing. Moreover, the reliability of the data that has been produced across both sample groups has been considerably strengthened by its overall consistency, and some significant results have been achieved.

²⁷ 119 S.Ct. 1167, 1178, 1999.

The data that has been found supports the broad consensus in the literature that the act of disguising or tracing handwriting will have a marked influence upon the appearance and structure of that writing. Results have shown that inscriptions that are disguised or traced are intimately related in that they share common characteristic features that are generally indicative of the artificial manner by which they have been produced.

Additional features were also identified that could be directly associated with specific types of deviant writing and which can allow for distinctions to be made between them. Moreover, when the current findings are evaluated in light of those reported in earlier research into simulations (Lafone, 2005), persuasive evidence indicates that deviant writing, in all its various forms, will typically exhibit distinctive elements by which it can be recognized.

Moreover, evidence was found to suggest that disguised writing will tend to incorporate those writing features that fall within the limits of the writer's natural variation: that is to say the range of natural differences and combination of differences in writing features that that can be observed to occur in and between the writings of an individual during the normal course of their writing (Dines, 1998, p.118). These unique, discriminating elements will generally provide convincing evidence of authorship. On the other hand, the data reveals that it is highly unlikely that a traced writing will be reliably associated with the tracer, since the writer's idiosyncratic writing habits will rarely be incorporated into their forgery.

Hitherto, any opinion evidence on deviant writing that has been presented by a document examiner in a court of law will have been based largely on his or her subjective reasoning, which is itself grounded on the examiner's training, experience and skill. But by the assignment of numerical values to each individual defining feature of deviant handwriting, this study provides the basis of an empirical statistical foundation by which the decisions of the handwriting expert can be guided and supported.

The examiner's capacity to recognize the discriminating features of deviant writing in a questioned document will ensure that the most comprehensive assessment of that writing can be made, and that ultimately more reliable conclusions about authenticity can be drawn and communicated to a jury. The classification that follows is, therefore, offered as a tool and a framework to assist the examiner in their analysis of possibly disguised and traced inscriptions, and as a guide for assessing the level of significance that they should apply to each discriminating feature that they observe in a questioned writing.

In order to capture and store the enormous amount of information that related to the participants' disguised, traced and natural writing samples so that the frequency of occurrence for each characteristic feature could be calculated, and so as to be able to collect all the demographic information relating to each of the study's participants, a computerised database had to be specially developed for this research²⁸.

²⁸ See Appendix XI for a detailed description of the structure of this database.

The database played an essential role in the analysis of the sample writing. Features that were said to be characteristic of deviant writing were consolidated from the empirical and anecdotal literature in order that they could be added systematically to the database. Essentially, this provided a checklist by which an examination of the sample writing could be made in a consistent manner.

However, before it was possible to begin the process of data collection, it was necessary to devise numerous queries, in a sufficiently simple and meaningful way, to ensure that all the relevant data relating to deviant writing and the samples of natural handwriting could be captured efficiently, and it was here that some lessons were learned. At the outset of this process, too many queries were written in sentence form which made the gathering of some information more difficult. By far the most efficient queries were those that elicited yes or no answers or those that prompted a numerical response, and researchers may wish to bear this in mind for any future studies.

The known samples of disguised and traced handwriting were then compared against the deviant characteristic features in the database for correspondence. Accordingly, when a specific feature was observed in the deviant writing sample it was ticked as present against the corresponding feature that was listed in the database; if this feature was not found to be present in the deviant sample, the relevant box remained unchecked. In this way any given feature could be objectively classified as a discriminating element of disguised or traced handwriting, and any feature that was described in the literature but not subsequently observed in the samples of deviant writing could be excluded from the final classification. With the aid of pivot tables, reports and manual investigations, the large amount of raw

numerical data that was collected for each characteristic was summarised and analysed, and the relative frequency for each individual feature was determined.

The following tables, therefore, summarise the numerical outcomes that have been determined and reported throughout this study. These outcomes are presented in tabular form to make it easy to see frequencies of occurrence. Every feature that appears in the tables is listed according to the weight of the statistical finding that relates to it and provides a relative probability, expressed as a percentage, of how often any one disguise might be encountered, or how frequently any specific characteristic might be expected to occur, either singly or in combination.^{clvii} If, for example, the examiner has observed the characteristic of acute angles in an examination of a questioned writing that they believe to be traced, their experience should tell them that such a feature is an indicator of traced writing; however, the examiner's conventional assessment can now be reinforced by reference to the taxonomy which will indicate that this is a characteristic that has been observed to have been present in 98% of a sample of writings that are known to be traced.

How this might be done can be illustrated by a brief exemplary analysis, taking one of the examples of traced writing that was collected during the course of this research and treating it as a questioned document: how can one determine whether it was a tracing or not? (A similar analysis may, of course, also be made of disguised writing). For brevity, the characteristics that are detailed are for illustration purposes only and are not intended to be an exhaustive list of all the features that can be observed in the tracing.

Error! Reference source not found. below is a tracing of a genuinely written signature, an example of which can be seen in Figure 93 .

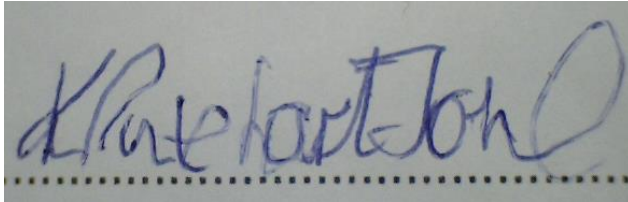


Figure 92: Traced Signature

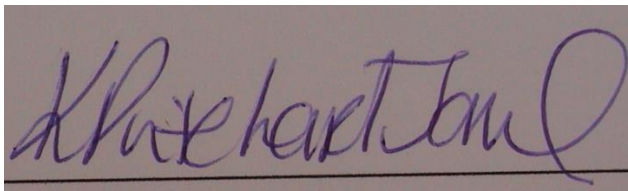


Figure 93: Naturally Made Signature

Using the section of the taxonomy that relates to traced forgeries as a means by which to guide the examination, it is possible to observe that the traced writing exhibits evidence of degenerated line quality which imparts a strikingly unnatural appearance to the writing.

In marked contrast to the smooth ink line that can be found in the genuinely written signature, the ink line in the tracing becomes uneven and disjointed as it is affected by clubbed blunt ends to nearly all of its strokes, acute angles in its curves which creates an angular appearance to what are smoothly curving strokes in the model writing, pen-lift in some connecting strokes, carefully made retouching, incorrect stroke direction, irregular stroke edges in the curved and down strokes, hesitation marks in the form of an ink blot, and an indentation mark at the beginning of down strokes and at directional changes.

In addition the tracing displays areas of heavy pressured writing that is revealed by thicker, darker lines. This absence of line width variation is interspersed with strokes that appear to be much lighter. In the genuine signature some of the lines are written as a lighter stroke, with less pressure applied to the pen, but the corresponding parts in the traced signature were made with a heavy pen pressure, which is evidenced by visible indentations on the reverse side of the paper. Not only does this suggest that the signature was made slowly, but it also indicates that it was created using the window method of tracing (see section 3.2.1), a fact that was subsequently confirmed by the writer. Because this method requires that the pen has to be held at an angle of 90 degrees, this has caused the ink flow of the pen to be impeded which has resulted in less ink being able to make contact with the paper. In consequence a lighter stroke is created.

The hairline strokes that are characteristic of the genuinely written signature and the dot over the lowercase letter 'i' have also been omitted from the tracing. It can also be observed that the tracing omits some stroke sequences. Incorrect line direction can be observed at some stroke ends and there some letter forms have been misinterpreted from the model signature.

The findings that have been detailed above are illustrated in the figures below.

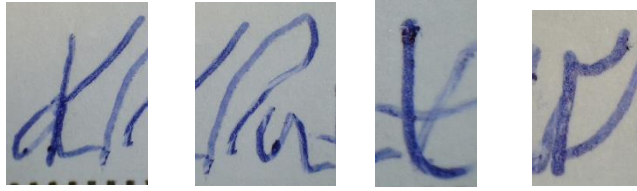


Figure 94: The Tracing Exhibits Blunt Ends in its Strokes

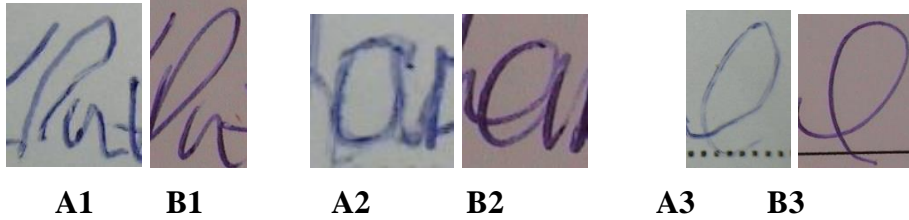


Figure 95: Acute Angles in A1, A2 and A3 are Absent in Genuine Signature B1, B2 and B3

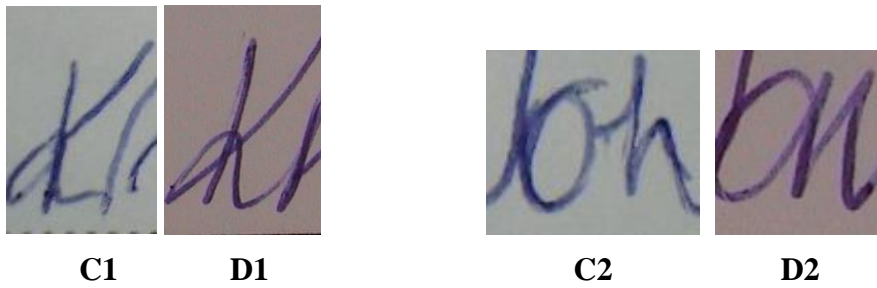


Figure 96: Pen Lifts in Tracing C1 and C2 is Absent in the connecting strokes of Genuine Signature D1 and D2

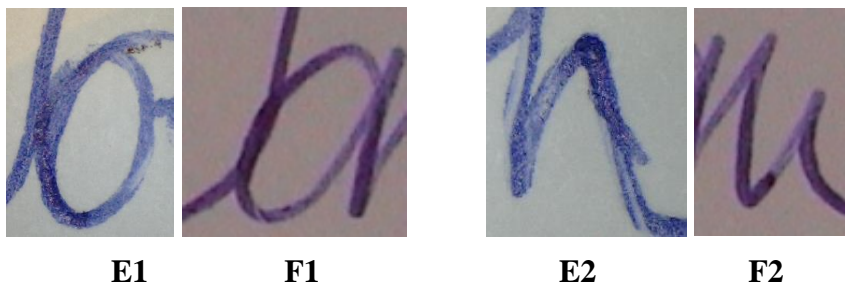


Figure 97: Retouching in E1 and E2 is Absent in Genuine Signature F1 and F2

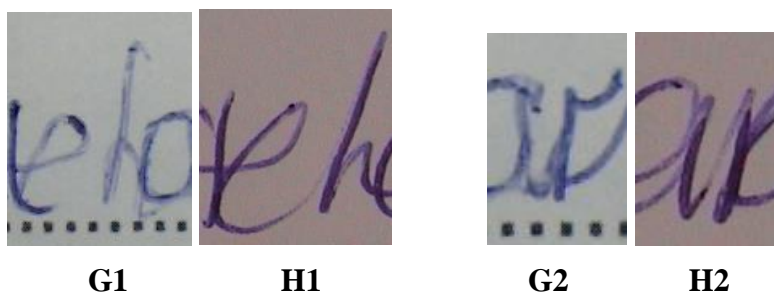


Figure 98: Hairline Strokes in the Tracing are Omitted in G1 and G2, and are Visible in the Genuine Signature H1 and H2

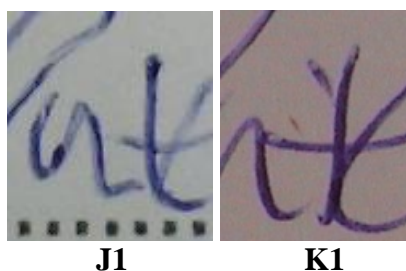


Figure 99: The Dot over the Lowercase Letter 'i' in the Genuine Signature K1 is Omitted in Tracing J1

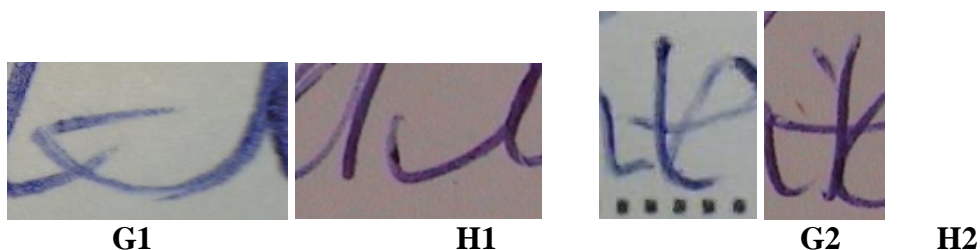


Figure 100: The Line Direction in Tracing G1 and G2 is absent in Genuine Signature H1 and H2

In a practical casework situation, the document examiner will have recorded all of the characteristics they have observed in the questioned writing that are, in his or her experience, characteristics of traced forgery, and conclude on this basis that the writing was unnaturally made and most probably traced. But it is now possible to reinforce that opinion by showing a jury examples of writing that are *known* to be traced, and showing that these characteristics are found in that set of known forgeries. The examiner can also cite

frequency of occurrence of each of the characteristics in the known sample. In the sample case under examination, these frequencies are as follows:

- Pressure variation – 100%
- Blunt ends – 100%: (blunt ends on every practicable disconnected stroke 70%)
- Acute angles – 98%
- Incorrect line direction: 98%
- Pen-Lifts – 97%
- Misinterpretation of letter forms: 96%
- Omission of Hairlines: 94%
- Irregular stroke edges – 93%
- Hesitation – 88%
- Retouching – 58%:
- Omission of 'i' dot: 76%

These figures certainly reinforce the opinion that the characteristics indicate traced forgery, and can be offered informally as evidence that the similarities between known forgeries and questioned writing are not merely coincidental. But can one extrapolate from these figures an estimate of likelihood of occurrence in any instance of traced writing? Can one use the taxonomy in this to incorporate its findings into a Bayesian paradigm for evaluating and interpreting handwriting evidence concerning deviant writing? The simple answer is no: or at least, not yet.

It is true that a ‘novel’ Bayes’ methodology has recently been applied to an examination of natural handwriting to quantitatively assess evidence ‘by means of a likelihood ratio designed for multivariate data’ (Marquis et.al., 2011, p.S238); but in order to develop a Bayesian methodology which is capable of providing the true likelihood that a questioned inscription is deviant because it is observed to contain a particular characteristic feature or features, other statistical information would need to be factored in to the equation, and the data that has been generated by this study provides only a part of that information: that is to say, the taxonomy provides a probability that a given characteristic will be present in deviant writing, but the findings do not provide a probability that the writing is deviant *because* it possesses a given characteristic.

In order to obtain the additional data that would be needed for a Bayesian methodology to work, information such as the possible frequencies of any deviant characteristics that might occur in natural handwriting, it would be necessary for subsequent studies to be performed, since there is not, at present, any empirical statistical information available from which to derive this information.

Nevertheless, as it currently stands, the taxonomy may be considered of significance for several reasons. At present there is no commonality in presenting forensic handwriting evidence, nor is there a method of analysis that is agreed upon by those in the field that can form the basis of this handwriting evidence, nor is there a common lexicon that has generally been agreed upon to describe the idiosyncratic features that serve to distinguish deviant writing. Accordingly, the classifications that have been presented here can, if generally accepted among document examiners, be used as a common language for describing the elements that are said to distinguish deviant writing in the reports written by

handwriting experts and in the evidence they give to the courts. The importance of effective communication is a mechanism that encourages knowledge sharing and helps knowledge acquisition. Some level of uniformity is, therefore, required throughout the discipline so as to facilitate future efforts for more refined measurement and testing and it is hoped that the taxonomy will go some way to promote such consistency.

More importantly, the taxonomy presented in this thesis provides the basis for a structured and repeatable method of handwriting examination, something that has, until now, been lacking in the forensic handwriting community. The deviant characteristics that have been categorized serve to define the parameters of what should be examined by the handwriting examiner in their comparison of any questioned writing with known samples of natural handwriting, and provide a systematic means by which the observations of the examiner can be objectively summarised. This will help to ensure that document examiners treat similar cases alike: a concept that is ‘a fundamental aspect of justice’ (McKendrick, 2011, p.632). In addition the taxonomy can assist the document examiner and, ultimately the trier of facts, to determine the level of significance to attach to any particular characteristic feature of deviant writing. But, crucially, the taxonomy is intended to be a flexible tool, and as such, can be supplemented, enhanced and/or amended as and when new evidence comes to light.

Given the moderate sample size upon which this study was based, caution is, of course, advisable when extrapolating from the frequencies given in the taxonomy, since the sample size generated a margin of error that is comparatively wide ($\pm 10\%$ with a 90% confidence level). Nevertheless, the margin of error was derived using available standard methods for

calculating error margins²⁹ based on overall population size of those involved in forgery and fraud in the UK (19,682) and a sample size of 60. This means, according to the law of statistical probability, that for 18 out of every 20 times a result was found, we can be confident that it falls within the margin of error shown. The margin of error is clearly too wide for the findings from this study to be represented yet as universal laws, but it is predicted that the trends found do reflect the target population with sufficient accuracy to provide a meaningful insight into the phenomena of deviant writing.

Indeed, considerable attempts were made and the utmost care taken to promote the greatest integrity of the data. In order to achieve minimal sampling error, stratified random sampling was used to reflect the general UK population that currently engages in forgery and fraud to ensure that the target population was reflected as accurately as possible. Nevertheless, while recognizing the need to demonstrate reliability, it must be acknowledged that since the examination of handwriting is a lengthy process, the overall size of the sample was necessarily restricted to the analysis of the writing of 60 individuals who produced 420 disguised, traced and natural handwriting samples. This involved the input to a database of just over half a million separate data points, which was deemed a practicable amount that could reasonably be examined by a single researcher in the time constraints involved.

Notwithstanding the significance of the taxonomy as it currently stands, and the rigorous sampling techniques and methodologies that were employed in this research to obtain the most reliable data possible, it is nevertheless the case that in order to increase the statistical power of the present findings, it is essential that they are verified by the testing of a larger

²⁹ <http://www.select-statistics.co.uk/sample-size-calculator-proportion>

sample base, and in so doing considerably lessen the margin of error that exists in this present research and increase the confidence level. In so doing, it is predicted that the most accurate and robust results will be obtained and the larger sample will allow for the testing of true statistical significance.

The question then arises as to what sample size should be adopted in any follow-on survey? A final determination would, of course, need to be made by expert statisticians, but for guidance to subsequent researchers, and by employing once again the same standard method for calculating error margins as was used in this present study, it is estimated that to achieve a margin of error of $\pm 2\%$ and a confidence level of 99%, the minimum sample size that would be needed to reflect, as closely as possible, the true population would be approximately 3,500.

Fortunately, it is possible to estimate how such a study should work in practice. A large-scale statistical study on handwriting has begun recently in the United States (Vastrick, 2013), the methodology and experimental design of which, as it happens, follows very closely that which was developed (entirely independently) for this present study. The new study is using a sample base of 5,000 writers and is an attempt to provide a list of statistical frequencies for natural handwriting and handprinting features to demonstrate the level of uniqueness for any given handwriting. But it is significant that the project is described as statistical research into handwriting as opposed to a handwriting study using statistics (Vastrick, 2013). Rather than the work being guided by document examiners, it is instead being driven by a large staff of expert statisticians who are collaborating with document examiners. That experts in the field of forensic handwriting analysis should collaborate more closely with statisticians is vitally important, for only by joint application of their

various expertise will it be possible to ensure that the most accurate results can be achieved and communicated appropriately to a jury in court.

The involvement of statisticians is also held to be critical to the progression and development of this present study, where it has been demonstrated that it is possible and practicable to obtain numerical data on discrete elements of handwriting and to order these hierarchically. It is, therefore, predicted that by employing the experimental design that has been described in this study, and by ensuring that a solid statistical foundation is achieved by the supervision and contribution of statisticians, future testing of the findings that have been made here will not only increase the validity of the findings, but will also allow for those issues to be addressed that were beyond the scope of this present study.

In particular, a larger sample base would be capable of generating the considerable statistical data that would be necessary to examine the complex issue of interdependent effects among two or more discrete characteristic features, and/or among two or more groups of characteristic features. The characteristic traits that have been observed in deviant writing have been many and various, but too much significance, Harris (1958) warns, should never be placed on any one specific feature (p.650); on its own, the presence of a single characteristic will not serve to prove that a writing has been artificially made since it might, after all, be due to a simple and isolated aberration on the part of the writer, whereas an assessment of the combination of several characteristics can generally be expected to do so. If, for example, a questioned signature was observed to differ from natural known writing in that it contained blunted ends to all of the strokes that comprised it, acute angles in many or all of its curved strokes, numerous instances of pen lift, evidence of hesitation marks, together with uniformly dark strokes caused by an unusually

heavy pressure having being applied to the pen that was used to make the writing, the combination of all these features would serve to provide compelling evidence that the writing was deviant.

An examination and calculation of the significance of simultaneously occurring characteristic features was, however, impracticable within the scope of this present study, but it is considered to be valuable follow-on research to this work, since a statistical analysis of patterns of co-occurrence would help to considerably strengthen the diagnostic value of the features that have been classified individually here, which would ultimately lead to a better recognition of deviant handwriting.

A large-scale study built upon the findings of this current research would also allow for the substantial statistical work that would be required to establish if it is, in fact, possible to obtain sufficient data to accurately determine the minimum number of comparison points that could be deemed acceptable for a) a positive determination of deviant handwriting or b) a positive identification of the author of a disguised writing.

This study has demonstrated the ability to record the occurrence frequencies of the nature and locations of the characteristics that can be found in deviant writing, as well as the occurrence frequencies of the individual characteristics that the writers retained in their deviant writing, which would seem to offer the potential for establishing minimum point standards for determining uniqueness and/or deviancy in the field of forensic handwriting examination in the future. If such a determination is, therefore, achievable, it would greatly increase the validity of the practice of forensic handwriting examination, especially as

other forensic disciplines, such as fingerprint identification, which has long been heralded as the mainstay of criminal forensic investigation, has no internationally agreed minimum number of features to establish positive identification, since there has never been a comprehensive statistical study conducted 'to determine the frequency of occurrence of different details and their relative locations' (Girard, 2011, p.137).

It is clear that much still remains to be achieved by those within the field of forensic handwriting analysis, particularly in the examination of deviant writing. It has been suggested that this study can be extended to address the significance of co-occurring characteristics in deviant writing and, in the wake of this, to determine if deviancy can be established if a number of agreed points of similarity can be determined. This study has also made clear that while its results are founded on data that has been rigorously collected, it is, nevertheless, based on only a small sample so that it is necessary that the findings are validated and/or refined by means of a study that can draw on a larger sample base. But fundamental to any examination of questioned handwriting is its comparison with natural handwriting. It is therefore crucial that research is conducted to obtain solid statistical evidence on the individuality of handwriting in order to ensure that the most comprehensive evaluation can be made of the new findings that are presented here on deviant writing.

In particular, robust quantitative assessments are needed to classify the idiosyncratic features that serve to make up natural handwriting. It is, then, hoped that the work currently being undertaken by Vastrick will yield results that will be able to contribute in large part to filling the void of statistical evidence in the empirical literature through his quantifiable consideration of the principle of uniqueness in handwriting. If Vastrick's study succeeds in

being able to obtain statistical frequencies for numerous discrete natural handwriting features, a comparison of these natural findings with the deviant characteristics that have been identified in this research will greatly assist in strengthening or refining them, for it is only by an understanding of what is characteristic in natural handwriting that deviant writing can ever be properly recognized.

For the benefit of any researcher wishing to build upon the work that has been conducted here, the data that was collected during the course of this research can be accessed online by using the Deviant Handwriting Examination Data hyperlink that can be accessed through the following web site: <http://www.forensichandwritinguk.co.uk/>.

The research database was, however, unsuitable in its original form for uploading to the web, but it has been possible to make it into a suitable format by converting it to a Microsoft Excel 2013 spreadsheet. Because of this, it has been possible to provide a set of filters which allow for the results to be easily refined, so that any specific group of results can be accessed and viewed.

The following filter groups are available:

Disguise Type: The three types of deviant writing samples examined;
disguised extended text, disguised signature, traced writing

Characteristic Group: The characteristics of deviant writing tested

Sample Type The sample writing type; natural writing; disguised writing or traced writing

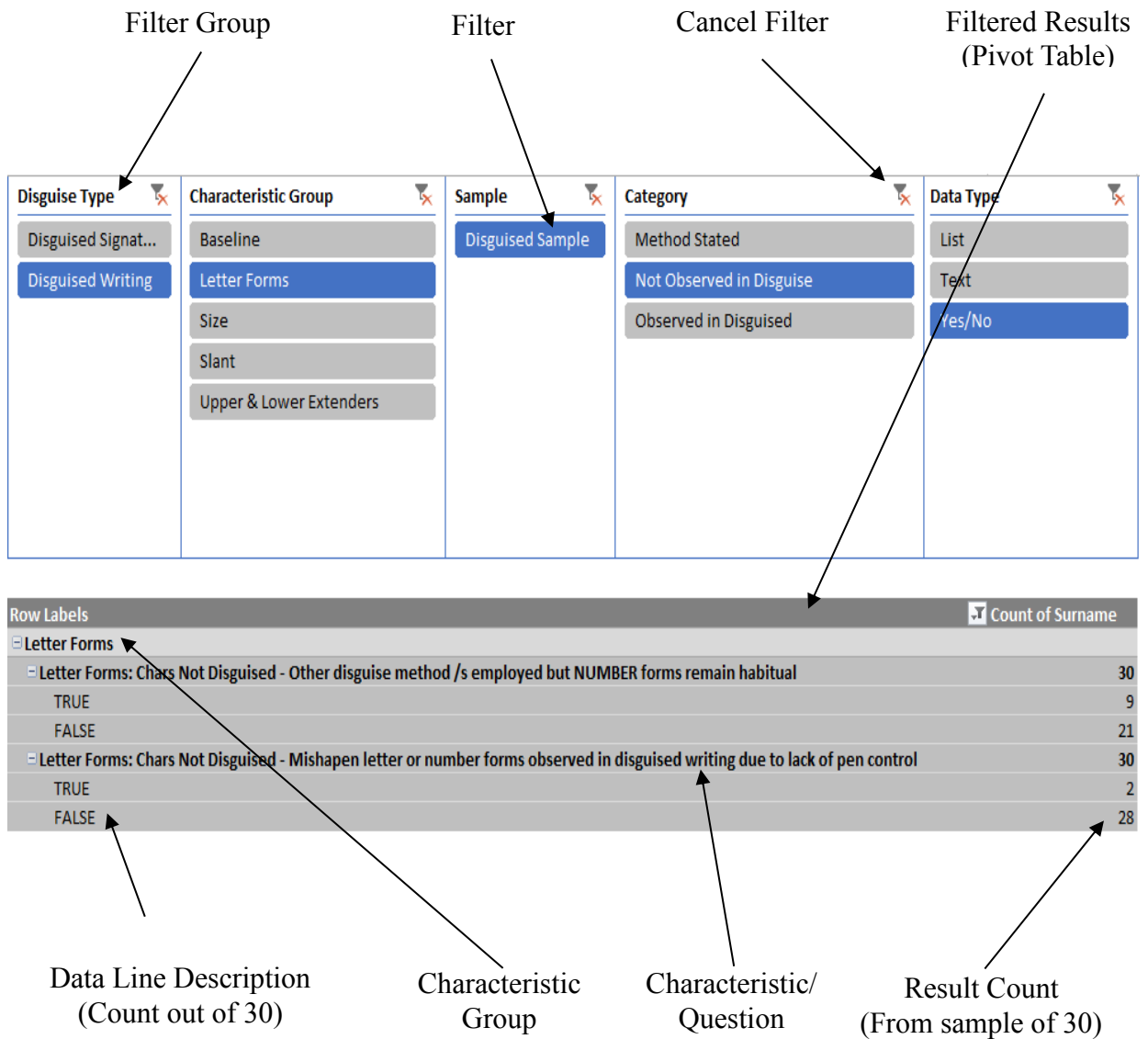
Category: Information given by the participants about the methods used to create their deviant writing and corresponding observations made by the researcher about these methods. It also includes the individual characteristics observed in the natural writing samples and the characteristics in the deviant samples.

Data Type: The type of data captured; Yes/No answers, listed answers (pull down menus), free text and numerical answers

A screenshot of the Deviant Handwriting Examination Database can be seen in

Figure 101 below.

Figure 101 - Deviant Handwriting Data Summary Pivot Table



Once filtered, the results can be viewed in the pivot table located under the *Characteristic Group* heading, and each result represents a count of the number of times a particular characteristic of deviancy was found.

As has already been mentioned, the database that was used to collect information in this study incorporated a data field for each characteristic feature which enabled the frequency of any characteristic to be reported. However, the database did not lend itself to a more holistic analysis of the data. With the more advanced pivot table 'slices', or filters, that have recently been introduced into Microsoft Excel in their latest version of the software, it has now been possible to reorganize the online data to provide a more complete overview of the information.

The original database was developed to be able to capture disparate information of unknown quantity to determine if it was possible to create a taxonomy of deviant writing. A huge number of data fields had, therefore, to be created, many of which were never used as the characteristic features were not anywhere observed in the samples. But the taxonomy that has resulted from the collection of this data has refined and narrowed the parameters for the information that would need to be collected in any future research. That is to say, the data fields in any new database can now be greatly reduced, since the only information that would need to be gathered is that which relates to the characteristics appearing in the taxonomy. By utilising this refinement of data, it is envisaged that a new database, constructed for the testing of a larger sample, could be simplified so that it would be capable of providing a simple checklist of features to be examined, and that the checklist would enable a simple Yes/No answer.

Figure 102 provides an example of how the data might possibly be presented in a simplified database, and could provide the relative frequency results for each specific characteristic level. It should, however, be noted that this example is for illustrative purposes only, since any data collected by a larger study should, as has already been

discussed, be guided by expert statisticians, to ensure that the most robust taxonomy is created.

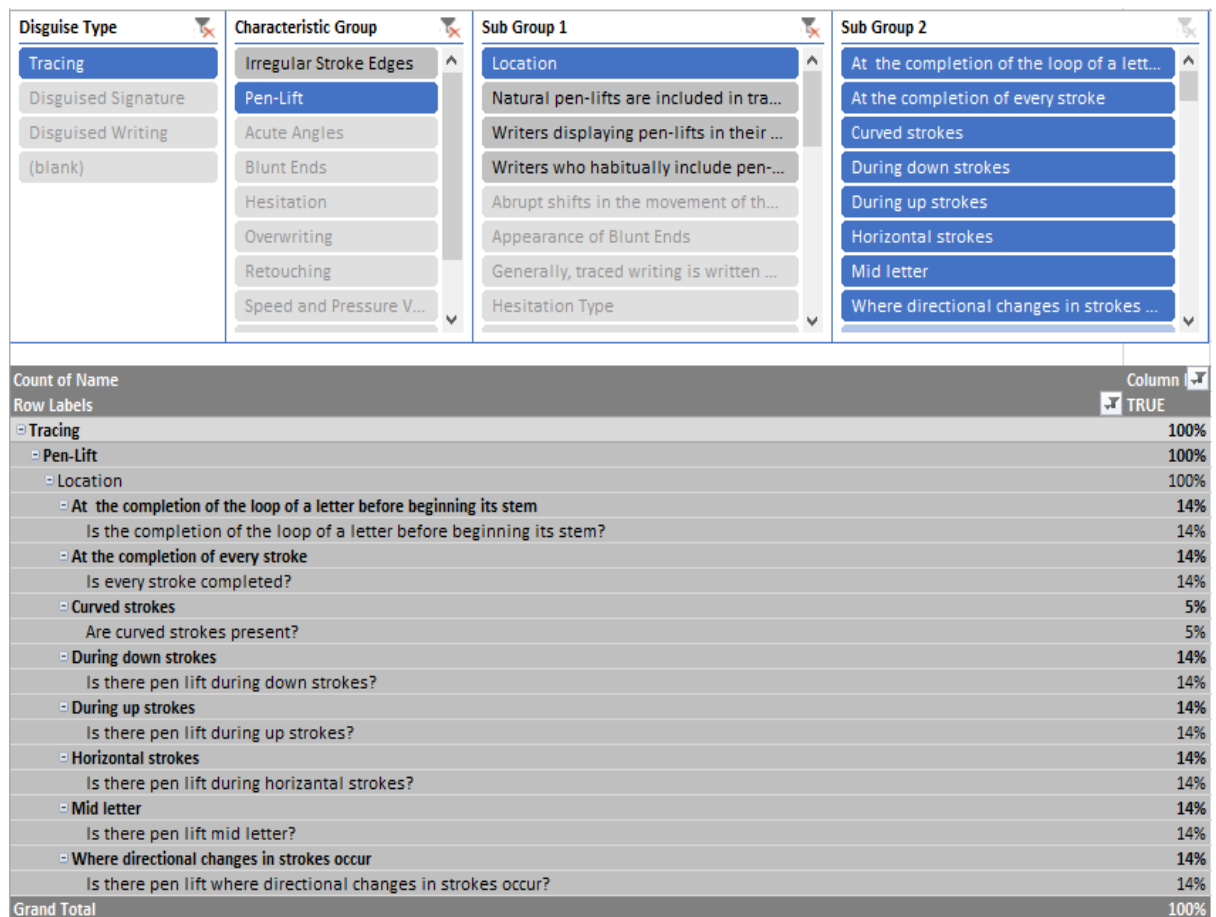


Figure 102: An Example of Data Capture in any Future Database

It is, perhaps, because of the complexity of the task, that there has not been a structured quantitative survey that has covered all the forms of deviant writing until now. There is no doubt that used appropriately, statistical knowledge can help to better inform the expert's assessments and conclusions; but statistics can, at present, only take us so far. Indeed, the present research provides a syntheses of quantitative and qualitative evidence which reflects the fact that handwriting experts are still needed to explain in semantic terms the

significance of the differences they observe in a questioned writing, just as an expert is still required to explain the findings of a DNA test. Statistical analysis should, therefore, be used to support the conclusions of the handwriting expert, not to replace them, so that the court can achieve a better understanding of the accuracy and significance of those conclusions. In this way the opinions of the handwriting examiner will go beyond that of mere speculation and will avoid the use of probabilities without numbers, thus providing the court with the resources they need to determine more effectively the weight and credibility to assign to an expert's evidence.

It is envisaged that the significance of forensic science to the criminal justice system is going to 'intensify in the years to come' (Great Britain. HC-96-1, 2005, § 81 and HC-96-II, 2005, § 185). It therefore seems certain that the handwriting expert will be expected to provide more quantitative evidence with which to defend and explain his or her conclusions. It is therefore imperative that the community continues to take positive action to test the knowledge claims and principles upon which it relies, as a failure to do so will almost certainly result in its practice and profession becoming defined by others (Rudin and Inman, 2006).

'[W]hen it is not in our power to determine what is true' Descartes (1637) tells us, 'we ought to act according to what is most probable'. Efforts must be maintained by those in the handwriting analysis profession to strive towards more empirical methodologies and probabilistic interpretations of their work; for it is only in so doing that handwriting analysis will receive widespread acceptance in the expert and legal communities as a reliable forensics provider. Accordingly, the taxonomic ranking of the characteristics of deviant handwriting that has been created is offered as a contribution towards the process

of attaining such recognition in an effort to ensure that our courts and juries will continue to benefit from the valuable ‘insights’ that the discipline of forensic handwriting analysis can, this study submits, undoubtedly offer.^{clviii}

PART VI

The Taxonomy

8 THE TAXONOMY

The tables which follow summarise the numerical outcomes that have been reported throughout this study in relation to handwriting that has been disguised or traced and is presented in tabular form to make it easy to see frequencies of occurrence. However, given the size of the sample, caution is advisable in extrapolating from these frequencies. Nonetheless, it is hoped that the findings will be genuinely useful in giving document examiners an indication of what to look for in possibly disguised and traced inscriptions.

Table 17 to Table 23 are concerned with disguise and list the principal methods that have been employed for camouflaging natural handwriting and categorise the characteristic features that have been associated with this form of deviant writing. Similar information relating to traced forgery is presented in Table 24 - Table 28. Table 29 and Table 30 provide information that is common to disguised, traced and simulated writing to allow for comparisons to be made across all forms of deviant writing.

Every feature that appears in the tables is listed according to the weight of the statistical finding that relates to it and provides a relative probability, expressed as a percentage, of how often any one disguise might be encountered, or how frequently any specific characteristic might be expected to occur: either singly or in combination.^{clix}

The tables may be read in conjunction with the Summary of Findings in Table 31 which provides a summary of the conclusions that have been made during the course of this work. The reference number that can be found alongside the main characteristic group headings in each table directs the reader to the relevant finding in Table 31.

Table 17: Primary Methods of Disguise

Classification of Handwriting Disguise Methods	Sub Group/s	Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)	
Writing Slant Alteration	Overall Occurrence	57	57	57	
	Rightward to leftward direction	Overall Occurrence	56	59	53
		<i>Forehand to Backhand</i>	53	50	56
		<i>Vertical to Backhand</i>	26	30	22
		<i>Forehand to Vertical</i>	21	20	22
	Leftward to rightward direction	Overall Occurrence	44	41	47
		<i>Vertical to Forehand</i>	80	86	75
<i>Backhand to Forehand</i>		20	14	25	
Numeral Alteration	Overall Occurrence	40	40	n/a	
	Numerals embellished with loops & curls	58	58		
	Introduction of European number 7	18	18		
	Introduction of printed forms	8	8		
	introduction of copybook forms	8	8		
	Increased size	8	8		
Letter Form Alteration	Overall Occurrence	27	33	20	
	Embellished only	57	80	33	
	Simplified only	17	0	33	
	Embellished & Simplified simultaneously	5	10	0	
	Design of new letter forms	22	10	33	
Upper & Lower Extender Modification	Overall Occurrence	25	37	13	
	Upper extensions	60	58	67	
	Lower extensions	40	42	33	
	Looped upper &/or lower extensions changed to plain	63	58	75	
	Plain upper &/or lower extensions changed to looped	37	42	25	
Writing Size Alteration	Overall Occurrence	23	23	23	
	Increased size	50	71	57	
	Decreased size	50	29	43	

Table 17: Cont'd...

Classification of Handwriting Disguise Methods	Sub Group/s	Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Writing Speed Alteration	Overall Occurrence	20	20	20
	Increased speed	50	50	50
	Decreased Speed	50	50	50
Handprinting	Overall Occurrence	17	23	10
	Printscript	40	43	33
	Manuscript	40	29	67
	Copy book printing	10	14	0
	Block lettering	10	14	0
Connecting Strokes Modification	Overall Occurrence	13	20	7
	Connections are made between letters that are unconnected in genuine writing	64	66	50
	Connections are removed between letters that are connected in genuine writing	12	17	0
	Additional connectors introduced & habitual connectors removed simultaneously	12	0	50
	Curved connectors are changed to angular strokes	12	17	0
Initial & Terminal Stroke Modification	Overall Occurrence	12	20	3
	Initial stroke	86	83	100
	Terminal stroke	14	17	0
	Embellishment of Initial/terminal strokes by addition of loops	43	33	100
	Initial/terminal strokes made more angular	29	33	0
	Initial/terminal strokes Introduced	14	17	0
	Initial strokes omitted	14	17	0

Table 17: Cont'd...

Classification of Handwriting Disguise Methods	Sub Group/s		Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Feigned Writing Care	Overall Occurrence		10	13	7
	Disguisers will tend to feign carelessness in their writing in order to camouflage it		100	100	100
Text Arrangement Altered	Overall Occurrence		3	7	0
	Decrease of lateral spacing habits with a simultaneous decrease in line spacing		100	100	n/a
Special Character Modification	Overall Occurrence		3	3	3
	i-dot alteration	<i>Insertion</i>	100	100	100
Use of the Non-Dominant Hand	Overall Occurrence		3	3	3
	Natural right hand exchanged for left		100	100	100

Table 18: Disguised Writing – Summary of Overall Characteristic Trends

Characteristic Trend	Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
The overall Likelihood that a disguised writing will exhibit evidence of degenerated line quality	100	100	100
The overall likelihood that a disguised writing will exhibit discernible inconsistency whether by a failure to maintain a chosen disguise or as a consequence of the disguise process	92	100	83
The overall likelihood that a disguised writing will exhibit written forms that are habitual to the writer	78	78	79

Table 19: Disguised Writing – Line Quality Characteristics

Characteristic Group	Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Degenerated Line Quality is Evidenced in Disguised Writing	100	100	100
Writing Speed and Pressure Variation*	92	96	88
Blunt Ends	73	73	73
Acute Angles in Curved Strokes	68	70	67
Hesitation Marks	50	80	20
Pen-Lift	45	60	30
Overwriting	32	60	0
Retouching	32	57	3
Tremor	8	8	8

* See also Table 21: Inconsistency as a By-Product of the Disguise Process

Table 19: Cont'd...

Characteristic Group	Sub Group/s	Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)	
Writing Speed and Pressure Variation [Table 15A: Ref. 10b]	Generally, disguised writing will be written more slowly and with a uniformly heavier pressure than that which is habitual to the disguiser	86	83	88	
	The slow, heavy pressured writing that tends to accompany disguised writing, will occasionally be interspersed with interludes of more variably shaded writing as the writer briefly returns to habitual writing speeds	9	4	12	
	Where an involuntary change in writing velocity is faster than that which is natural to the disguiser, this will be exhibited as a uniformly lighter writing pressure	7	12	0	
	Unintentional speed variation will always result in unnatural pressure patterns that will impart an abnormal appearance to the disguised writing	100	100	100	
Blunt Ends [Table 15A: Ref 16]	When 2 or more disguise methods are employed simultaneously to disguise extended text, blunt ends will increase in frequency	67	67	n/a	
	Writers who do not produce blunt ends in their usual writing will do so in their disguises	80	83	76	
	Writers who produce blunt ends in their usual writing will continue to incorporate these into their disguises while increasing the number they produce	58	50	67	
	Location of Blunt Ends	<i>Beginning stroke</i>	32	27	41
		<i>End stroke</i>	32	29	38
<i>Hooked stroke</i>		19	24	9	
<i>Dragged strokes</i>		17	19	12	

Table 19: Cont'd..

Characteristic Group	Sub Group/s		Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Blunt Ends (Cont'd.) [Table 15A: Ref 16]	Appearance of Blunt Ends	<i>Clubbed</i>	75	75	75
		<i>Fishtail</i>	25	25	25
Acute Angles in Curved Strokes [Table 15A: Ref. 17]	Curved stokes become angular as a by-product of the disguise process		68	70	67
Hesitation Marks [Table 15A: Ref. 18]	Hesitation Types	<i>A firm clear mark found near or alongside a written stroke</i>	46	54	20
		<i>An ink blot on a written stroke</i>	38	34	60
		<i>An indentation mark on a written stroke</i>	8	8	0
		<i>A sudden short, jagged appearance to an otherwise smooth stroke.</i>	8	4	20
	Location of Hesitation	<i>Beginning of Down Strokes</i>	60	60	60
		<i>Beginning of Initial Stroke</i>	12	12	20
		<i>On the terminal stroke of one letter before starting the initial stroke of another</i>	12	16	0
		<i>Curved/ looped strokes</i>	6	4	20
		<i>Beginning of horizontal strokes</i>	5	4	0
		<i>Connector strokes</i>	5	4	0

Table 19: Cont'd..

Characteristic Group	Sub Group/s	Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)	
Pen-Lift [Table 15A: Ref. 19]	Location of Pen-Lift	<i>Connecting Strokes</i>	40	34	56
		<i>Curved strokes</i>	28	27	33
		<i>Mid letter</i>	8	11	0
		<i>Where directional changes in strokes occur</i>	6	8	0
		<i>Mid word</i>	6	8	0
		<i>Horizontals</i>	6	4	11
		<i>Angled strokes</i>	3	4	0
		<i>Down strokes</i>	3	4	0
	Pen-lifts are carelessly made	54	59	49	
	Pen-lifts are carefully made	46	41	51	
	Writers displaying pen-lifts in their natural writing	20	27	13	
	Natural pen-lifts are included in disguised writing	100	100	100	
	Writers who habitually include unnatural pen-lifts in their natural writing will increase the number of pen-lifts in their disguises	100	100	100	

Table 19: Cont'd..

Characteristic Group	Sub Group/s		Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)	
Overwriting and Retouching: [Table 15A: Ref. 20]	Reason for Retouching	<i>To maintain the integrity of the disguise</i>	83	88	0	
		<i>To conceal identifying features</i>	11	6	100	
		<i>To improve legibility</i>	6	6	0	
	Reason for Overwriting	<i>To maintain the integrity of the disguise</i>	61	61	n/a	
		<i>To conceal identifying features</i>	33	33	n/a	
		<i>To improve legibility</i>	6	6	n/a	
	Location:	<i>Curves</i>	87	86	100	
		<i>Punctuation</i>	10	11	0	
		<i>Down strokes</i>	3	3	0	
	Overwriting is made with strokes that move in the opposite direction to those they seek to repair			56	56	n/a
	Retouching is made with strokes that move in the opposite direction to those they seek to repair			61	65	0
	Retouching: Care of Execution	<i>Retouching is carefully made</i>	97	94	100	
		<i>Retouching is carelessly made</i>	3	6	0	

Table 19: Cont'd..

Characteristic Group	Sub Group/s		Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Overwriting and Retouching (Cont'd..) [Table 15A: Ref. 20]	Overwriting: Care of Execution	Overwriting is carefully made	94	94	n/a
		<i>Overwriting is carelessly made</i>	6	6	n/a
Tremor [Table 15A: Ref. 21]	Tremor Type	<i>Gross</i>	51	53	48
		<i>Fine</i>	49	47	52
	Location of Tremor	<i>Curved strokes</i>	58	61	50
		<i>Down strokes</i>	27	33	12
		<i>Horizontal strokes</i>	11	6	25
		<i>Up strokes</i>	4	0	12

Table 20: Inconsistency Due to a Failure to Maintain a Specific Disguise

Method of Disguise Employed	Characteristic Detail	Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Disguised Writing Exhibits Inconsistency Caused by the Writer's Failure to Maintain a Chosen Disguise		90	96	81
Connecting Strokes	Attempts to deliberately modify connecting strokes will be inconsistent	100	100	100
Initial/Terminal Strokes	Attempts to deliberately modify initial &/or terminal strokes will be inconsistent	100	100	100
Letter Forms	Attempts to deliberately modify letter forms will be inconsistent	100	100	100
Non-Dominant Hand	Attempts to disguise handwriting by use of the non-dominant hand will be inconsistent	100	100	100
Special Characters	Attempts to deliberately modify special characters will be inconsistent	100	100	100
Feigned Writing Care	Extended text disguised by the adoption of careless writing will exhibit abnormally distorted letter forms and haphazardly sized letters and numbers	100	100	n/a
Numerals	Attempts to deliberately modify numerals will be inconsistent	100	100	n/a
Text Arrangement	Attempts to deliberately modify arrangement patterns will be inconsistent.	100	100	n/a
Writing Slant	Attempts to deliberately modify slant will tend to be inconsistent	94	94	94
Writing Speed	Attempts to deliberately modify writing speed will tend to be inconsistent	92	100	83
Upper/Lower Extenders	Attempts to deliberately modify upper &/or lower extenders will tend to be inconsistent	87	91	75
Writing Size	Attempts to deliberately modify writing size will tend to be inconsistent	78	100	43
Handprinting	Attempts to disguise handwriting by handprinting will generally be inconsistent	75	75	n/a

Table 20: Cont'd..

Method of Disguise Employed	Sub Group/s	Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Connecting Strokes Modification [Table A15: Ref. 1a]	When connecting strokes are disguised, they will revert frequently to the writer's habitual way of forming these strokes	75	83	50
	Where disguised connectors have been omitted from a written disguise, writers will sometime touch these in after a word has been completed	55	60	50
	The addition or omission of connectors from an extended disguised writing will tend to be inconsistent	67	67	0
	Connectors that have been disguised by the substitution of rounded strokes to more angular ones, will sometimes exhibit inconsistency in their slant and will display awkwardly made movements in the written line	24	35	13
Initial & Terminal Stroke Modification [Table A15: Ref. 2]	Disguised Initial &/or terminal strokes will revert to that which is habitual for the writer	86	75	100
	Alterations to initial &/or terminal strokes will sometimes be inserted after the overall disguise has been completed	29	25	33
Letter Form Alteration [Table A15: Ref. 3a]	Disguised letter forms will revert to that which is habitual to the writer	88	100	67
	The form of Structurally related letters will tend not to be similarly altered	69	90	33
	When a signature is disguised by an alteration of form, the first occurring capital may be altered, but subsequent capitals will tend to be left undisguised	60	n/a	60

Table 20: Cont'd..

Method of Disguise Employed	Sub Group/s	Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)	
Use of Non-Dominant Hand [Table A15: Ref. 4]	Constant and obvious fluctuations in writing size and slant will occur	100	100	100	
	Connecting strokes will become erratic in slant, usage and proportion	100	100	100	
	Cross-bar strokes in extended disguised text will tend to be produced erratically, with strokes sometimes moving in the wrong direction	100	100	n/a	
	The use of the non-dominant hand will create an appearance that will be strikingly disjointed arrhythmic, and unnatural	100	100	100	
	Looped structures will be negatively affected when the non-dominant hand is used to effect a disguise	<i>Ovals and Circles will tend to become clockwise when the non-dominant hand is used.</i>	100	100	100
		<i>The ink lines of the majority of looped formations will oscillate, causing strokes to become alternately angular &/or zigzagged in appearance</i>	100	100	100
	Gross letter distortion will be present	100	100	100	
Special Character Modification [Table A15: Ref. 5]	Structurally similar letters will tend not to be similarly altered e.g. j and i	100	100	100	
	Deliberate modifications to special characters will tend to revert to a form that is habitual to the writer	100	100	100	

Table 20: Cont'd..

Method of Disguise Employed	Sub Group/s		Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Feigned Writing Care [Table A15: Ref. 6]	Extended text disguised by the adoption of careless writing will exhibit abnormally distorted letter forms and haphazardly sized letters and numbers		100	100	n/a
Numeral Alteration [Table A15: Ref. 7]	When numeral disguise is attempted, only some numbers will be modified, the rest will remain habitual to the writer		92	92	n/a
	Successive numbers in a text will sometimes be disguised differently each time.		8	8	n/a
	Numerals occurring in dates and times will tend to remain undisguised	<i>Entirely</i>	67	67	n/a
		<i>Numerals occurring at the end of dates &/or times will remain undisguised</i>	33	33	n/a
Text Arrangement Habits Altered [Table A15: Ref. 8a & 8c]	Lateral and Vertical Spacing	<i>Deliberate modifications to lateral spacing habits will result in uneven, irregular spacing between letters and words</i>	100	100	n/a
		<i>Deliberate modifications to vertical spacing habits will result in uneven, irregular spacing between lines</i>	100	100	n/a
	Arrangement of Writing on Envelopes	<i>Modified arrangement patterns will revert back to that which is habitual for the disguiser</i>	100	100	n/a

Table 20: Cont'd..

Method of Disguise Employed	Sub Group/s		Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Writing Slant Alteration [Table A15: Ref. 9a & 9c]	Assumed slant will tend to revert to that which is habitual to the writer		94	94	94
	Double letters, especially ll; oo; ss; ee; rr will revert to disguiser's natural slant during longer written disguises		84	84	0
	A marked deterioration in the appearance of the disguised writing will occur, due to sudden changes in slant direction		85	88	82
Writing Speed Alteration [Table A15: Ref. 10a]	Attempts to modify natural writing speed will result in an unnaturally erratic writing appearance		83	83	83
	When writing speed is modified, it will revert back to that which is natural for the writer		58	67	50
		<i>Disguised speed will tend to revert to the writer's natural towards the end of the disguised writing</i>	71	75	67
		<i>Disguised speed will revert to the writer's natural speed throughout the disguised writing</i>	29	25	33
Upper & Lower Extender Modification [Table A15: Ref. 11]	Disguised upper &/or lower extenders will revert to forms that are habitual to the writer		67	90	0
	In extended disguised text, the first occurring upper or lower extender in a word will sometimes be the only such stroke to be altered.		27	27	n/a

Table 20: Cont'd..

Method of Disguise Employed	Sub Group/s	Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Writing Size Alteration [Table A15: Ref. 12a]	Double letters will tend to remain habitual to the writer even when a deliberate modification has been made to the size of other letters	80	71	100
	Assumed writing size will revert to that which is natural to the writer	50	71	29
Handprinting [Table A15: Ref. 15]	Disguised handprinting will revert to that which is habitual to the writer	80	71	100

Table 21: Inconsistency as a By-Product of the Disguise Process

Characteristic Group	Characteristic Detail	Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Disguised Writing Exhibits Inconsistency as a By-Product of the Disguise Process		70	90	50
Writing Speed* & Pressure	Accidental changes in writing velocity and pressure will tend to occur in disguises where no deliberate modifications to these features have been attempted	92	96	88
Writing Size	Accidental changes in writing size will tend to occur in disguises where no deliberate modification of natural size has been attempted	83	78	87
Writing Slant	Disguises in which a modification of slant has not been attempted will display abrupt, sporadic shifts in writing slope as a by-product of the process of disguise	58	75	42
Connecting Strokes	Connecting strokes become inconsistently slanted and display awkward movements in the ink line	50	63	39
Text Arrangement	Overall incidence of unintentional change to text arrangement in disguised writing	73	86	60
Cross-Bar Strokes	Cross-bars will become inconsistent in form during the disguise process	45	57	33
Letter Forms	Inconsistent letter forms occur in writing that has been disguised by means other than form alteration	43	60	29
Proportion	Unintended proportional changes occur in disguised writing	17	20	13

* See also Table 19: Disguised Writing – Line Quality Characteristics

Table 21: Cont'd....

Characteristic Group	Characteristic Detail	Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Writing Speed and Pressure Variation* [Table A15: Ref. 10b]	Generally, disguised writing will be written more slowly and with a uniformly heavier pressure than that which is habitual to the disguiser	86	83	88
	The slow, heavy pressured writing that tends to accompany disguised writing, will occasionally be interspersed with interludes of more variably shaded writing as the writer briefly returns to habitual writing speeds	9	4	12
	Where an involuntary change in writing velocity is faster than that which is natural to the disguiser, this will be exhibited as a uniformly lighter writing pressure	7	12	0
	Unintentional speed variation will always result in unnatural pressure patterns that will impart an abnormal appearance to the disguised writing	100	100	100
Writing Size [Table A15: Ref. 12b]	Accidental changes in writing size will tend to occur in disguises where no deliberate modification of natural size has been attempted	83	78	87
	The overall size of disguised writing will tend to increase when methods <i>other</i> than form alteration have been used	64	80	50
	When <i>form</i> is deliberately altered, the overall size of disguised writing will tend to increase	50	72	29

* See also Table 19: Disguised Writing – Line Quality Characteristics

Table 21: Cont'd..

Characteristic Group	Characteristic Detail	Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)	
Writing Size (Cont'd...) [Table A15: Ref. 12b]	When <i>form</i> is disguised, the overall size of modified writing will tend to decrease	43	14	71	
	When <i>form</i> is disguised, the modified writing will generally fluctuate between that which is larger and that which is smaller than the writer's natural writing.	7	14	0	
	Looped formations may accidentally decrease in size when writers deliberately increase their natural writing slope	22	30	13	
	Looped formations will, very rarely, increase in size when writers deliberately decrease their natural writing slope	3	3	3	
Writing Slant [Table A15: Ref. 9b & 9c]	Disguises in which a modification of slant has not been attempted will display abrupt, sporadic shifts in writing slope a by-product of the process of disguise.	58	75	42	
	The methods of disguise that tend to cause erratic slant variation in disguises that have not been modified by a deliberate alteration of slant are:	<i>Alteration of form</i>	58	56	60
		<i>Alteration of speed</i>	21	33	0
		<i>Use of unaccustomed hand</i>	14	11	20
		<i>Alteration of Size</i>	7	0	20
	Erratic shifts in writing slope will tend to fluctuate between forward, back and vertical slopes.	79	89	60	
	Erratic shifts in writing slope will sometimes only fluctuate between a forward slope & the writer's natural slant.	14	11	20	
	Erratic shifts in writing slope will sometimes only fluctuate between a vertical slope & the writer's natural slope.	7	0	20	
Slant inconsistency in a disguised writing will tend to result in a writing appearance that is strikingly arrhythmic and untidy.	86	89	80		

Table 21: Cont'd..

Characteristic Group	Characteristic Detail		Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Connecting Strokes [Table A15: Ref. 1b]	Connecting strokes will sometimes become inconsistently slanted and display awkward movements in the ink line		50	63	39
Text Arrangement [Table A15: Ref. 8b]	Overall incidence of unintentional change to text arrangement in disguised writing		73	86	60
	Lateral & Vertical Spacing	<i>Natural spacing that is not disguised, will undergo accidental change as a direct consequence of the disguise process and will become irregular in appearance</i>	41	34	46
		<i>Lateral Spacing</i>	88	70	100
		<i>Vertical Spacing</i>	30	30	n/a
		<i>When natural spacing is not deliberately modified, the vertical spacing between lines of text will tend to remain habitual to the writer, even when unintended changes occur to the lateral spacing in the text</i>	67	67	n/a

Table 21: Cont'd...

Characteristic Group	Characteristic Detail		Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Text Arrangement (Cont'd.) [Table A15: Ref. 8d]	Baseline Alignment	<i>Baseline alignment will generally become inconsistent as an unintended consequence of other disguises</i>	47	57	37
		<i>Baselines will fluctuate erratically during disguise</i>	39	23	64
		<i>Baseline alignment will become gross exaggerations of the disguiser's natural baseline</i>	14	23	0
		<i>Baseline alignment will tend to ascend upwards to the right during disguise.</i>	46	54	36
		<i>Extended texts in which the baseline ascends upward to the right, will often have employed back slant as a disguise method</i>	67	67	0
		<i>Disguised writing will often display a baseline that is entirely habitual and attributable to the disguiser</i>	53	43	63

Table 21: Cont'd..

Characteristic Group	Characteristic Detail		Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Cross-Bar Strokes [Table A15: Ref. 14]	A writer's habitually straight cross-bars will be inconsistently produced during the disguise process		45	57	33
	Cross-bars may become serpentine (wavy) in appearance		81	76	90
	Cross-bars may be formed differently at each occurrence		11	18	0
	Cross-bars may become curved in appearance		4	6	0
	Cross-bars may become zigzagged in appearance		4	0	10
	When the non-dominant hand is used to disguise extended text, Cross-bars will tend to be produced with noticeably erratic strokes often moving in the wrong direction		100	100	n/a
Letter Forms [Table A15: Ref. 3b]	Disguise methods associated with letter form inconsistency	<i>Slant alteration</i>	50	44	56
		<i>Size alteration</i>	22	21	22
		<i>Printing</i>	16	21	11
		<i>Care alteration</i>	12	14	11
	Letter form inconsistency caused by a loss of pen control		100	100	100
Proportion [Table A15: Ref. 13]	Unintended proportional changes will sometimes occur in disguised writing		17	20	13

Table 22: Disguised Writing – Retention of, or Reversion to Habitual Writing Elements

Disguise Method or Writing Element	Characteristic Detail		Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Disguised Writing Exhibits Written Forms that are Habitual to the Writer [Table A15: Ref. 22]			97	97	97
Line Quality: Habitual Elements Retained in Disguised Writing	Pen-Lift	<i>Disguisers will incorporate habitual patterns of pen-lift in their disguises</i>	100	100	100
	Blunt Ends	<i>Disguisers who produce blunt ends in their usual writing will tend to incorporate these in their disguises</i>	58	50	67
Use of the Non-Dominant Hand	Disguisers will be unable to remove or camouflage their idiosyncratic writing habits		100	100	100
Text Arrangement	Disguised Lateral & Vertical Spacing	<i>When natural spacing is deliberately modified, some or all of the disguisers Idiosyncratic lateral spacing habits will be retained in their disguise</i>	100	100	n/a
	Natural Lateral & Vertical Spacing	<i>When natural spacing is not disguised, writers will retain in whole or in part the word &/or line spacing as that exhibited in their genuinely made writing</i>	91	100	82
		<i>When natural spacing has not been disguised, the vertical spacing between several lines of text will tend to remain habitual to the writer even when accidental changes occur to the lateral spacing in the text</i>	67	67	n/a
	Natural Baseline	<i>Disguised writing will often display a baseline that is entirely habitual and attributable to the disguiser</i>	53	43	63
Writing found on Envelopes	<i>The distinctive way in which writers arrange their writing on an envelope will tend to remain unmodified during disguise.</i>	92	92	(n/a)	

Table 22: Cont'd...

Method of Disguise Employed	Characteristic Detail	Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Special Characters	Special characters will tend not to be targeted for disguise and will remain habitual to the disguiser	97	97	97
	When an attempt is made to disguise special characters, the modified strokes will revert to those which are habitual to the writer	100	100	100
Writing Slant	Assumed slant will tend to revert to that which is habitual to the writer.	94	94	94
	Double letters, especially ll; oo; ee and rr will revert to disguiser's natural slant during longer written disguisers	84	84	n/a
Proportion	Writing proportions will tend to remain habitual to the writer when other elements of the writing are disguised	93	100	87
	The size ratio between individual names of the natural signature will tend to be reproduced in the disguised signature	84	n/a	84
Initial & Terminal Strokes	Initial and terminal strokes will tend not to be targeted for disguise and will remain with the writer's range of natural variation	88	80	97
	Disguised initial &/or terminal strokes will revert to that which is habitual for the writer	86	75	100
Letter Forms	Disguised letter forms will revert to that which is habitual to the writer	88	100	67
	When the letter forms of a signature are disguised, the modified forms will often fall entirely within the range of the writer's individual characteristics	65	n/a	65
Connecting Strokes	Connecting strokes will tend to remain habitual to the writer when other elements of writing are disguised	87	80	93
	Those connecting strokes that are disguised will frequently revert to a form that is habitual to the writer	75	83	50
Cross-Bar Strokes	Cross-bar strokes will tend not to be targeted for disguise and will often remain within the range of natural variation for the disguiser	83	97	70

Table 22: Cont'd..

Method of Disguise Employed	Characteristic Detail	Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Handprinting	Handprinting that is disguised will revert to that which is habitual to the disguiser	80	71	100
	Writers attempting to disguise their natural cursive hand by printing will tend to use a form of handprinting that will be within the limits of their natural variation	60	60	n/a
	Those writers who attempt to disguise their natural handprinting will tend to revert to habitual methods of printing as their disguise progresses.	71	71	n/a
	Writers attempting to disguise their signature by printing will tend to use a form of handprinting that will be within the limits of their natural variation.	100	n/a	100
Upper & Lower Extenders	Upper & lower extenders will tend not to be targeted for disguise and will remain within the writer's range of natural variation	75	63	87
	When a disguise of the upper and/or lower extenders is attempted, the modified strokes will revert to a form that is habitual to the writer	67	90	0
Numerals	The majority of disguisers will not disguise the numerals in a text	60	60	n/a
	When numeral disguise is attempted, only some numbers will be modified, the rest will remain habitual to the writer	92	92	n/a
Writing Size	An assumed writing size will revert to that which is habitual to the writer	50	71	29
	The size of double letters will tend to remain habitual to the writer, even when a deliberate modification has been made to the size of other letters	75	71	100

Table 22: Cont'd..

Method of Disguise Employed	Characteristic Detail		Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Writing Speed	Natural Writing Speed	<i>The slow, heavy pressured writing that tends to accompany disguised writing, irrespective of the disguise method used, will occasionally be interspersed with occurrences of more variably shaded writing as the writer briefly returns to habitual writing speeds</i>	9	4	12
	Disguised Writing Speed	<i>Disguised writing speeds will revert back to that which is natural to the writer</i>	58	67	50

Table 23: Characteristics Associated with Specific Disguise Methods

Method of Disguise Employed	Characteristic Detail		Overall Percentage of Occurrence (%)	Percentage of Occurrence (Text) (%)	Percentage of Occurrence (Signatures) (%)
Use of the Non-Dominant Hand [Table A15: Ref. 4]	The most abundant and highly conspicuous errors will be manifest in a disguise made with the non-dominant hand		100	100	100
	Numerous & highly visible extraneous hairlines will be present which will bisect letters, numbers and words and will be found in spaces that would in natural writing typically be left blank		100	100	100
	The ink lines of the majority of looped formations will oscillate, causing strokes to become alternately angular and/or zigzagged in appearance		100	100	100
	During disguise made with the unaccustomed hand, looped formations will often be made in the opposite direction to that which is usual for the writer. The letters 'o' and 'q' will be particularly affected		100	100	100
	The majority of cross-bar strokes in extended disguised text made with the unaccustomed hand will be produced erratically with strokes often moving in the wrong direction		100	100	n/a
Feigned Writing Care [Table A15: Ref. 6]	Reduced Legibility	<i>Legibility will tend to be reduced considerably. This will cause disguised extended text to become obviously untidy & uncontrolled in appearance. Signatures will tend to become scrawled and entirely illegible</i>	100	100	100
		<i>Distorted &/or indiscernible letter forms will be observed</i>	100	100	100
	Hesitation	<i>Highly conspicuous marks of hesitation will be observed</i>	83	100	50

Table 24: Primary Methods of Tracing

Classification of the Methods of Traced Forgery	Sub Group/s		Overall Percentage of Occurrence (%)
Direct Tracing	Overall Occurrence		86
	Transmitted Light Process	<i>Window Method</i>	49
		<i>Artificial Light Source (e.g. a photographic light box or one that has been handmade using readily available materials)</i>	27
	Direct Overlay	<i>The sheet on which the traced signature is to be made is laid over the model signature. with no artificial light source employed</i>	24
Indirect Tracing	Overall Occurrence		14
	Indented Guidelines		50
	Pencil Guideline Technique		0
	Pin Prick Guidelines		0
	Guidelines made by Transference Techniques	<i>Tracing Paper</i>	50
		<i>Carbon Paper</i>	0

Table 25: Traced Forgery – Summary of Overall Characteristic Trends

Characteristic Trend	Overall Percentage of Occurrence (%)
Traced writing exhibits evidence of degenerated line quality	100
Traced writing exhibits discernible inconsistency with the model writing it copies	100
Traced writing exhibits written forms that are habitual to the writer	9

Table 26: Traced Forgery – Line Quality Characteristics

Characteristic Group	Characteristic Sub Group &/or Detail	Overall Percentage of Occurrence (%)
Degenerated Line Quality is Evidenced in Traced Forgery		100
Blunt Ends		100
Speed and Pressure Variation		100
Acute Angles		98
Pen-Lift		97
Irregular Stroke Edges*		93
Tremor		93
Hesitation**		88
Retouching		58
Overwriting		19

* See also Table 28: Characteristics Associated Specifically with Traced Forgery

** See also Table 28: Characteristics Associated Specifically with Traced Forgery

Table 26: Cont'd..

Characteristic Group	Characteristic Sub Group &/or Detail		Overall Percentage of Occurrence (%)
Blunt Ends [Table A15: Ref. 23]	Location of blunt ends	On every practicable disconnected stroke	70
		On intermittent strokes	30
		<i>Beginning of down stroke</i>	9
		<i>Beginning of Initial Stroke</i>	9
		<i>Beginning of terminal stroke</i>	8
		<i>End of down stroke</i>	8
		<i>Beginning of up stroke</i>	8
		<i>End of Up stroke</i>	8
		<i>Beginning of cross stroke</i>	8
		<i>End of cross Stroke</i>	7
		<i>Beginning of curved strokes</i>	7
		<i>End of curved strokes</i>	7
		<i>Beginning of flourish stroke</i>	7
		<i>End of flourish</i>	7
<i>Connecting strokes</i>	7		
	Appearance of Blunt Ends	Clubbed	87
		Fish-tail	13
Speed and Pressure Variation [Table A15: Ref. 24]	Generally, traced writing is written more slowly and with a uniformly heavier pressure than that of the model it copies, or that which is habitual to the disguiser.		98
	Tracings are made slowly, which is revealed by an absence of fine pen lines or hairlines		100
	Tracings are made with a heavy pen pressure		98
	Uniformly heavy pressure is revealed by unvarying dark strokes		96
	Uniformly slow and heavy pressured writing is revealed by an absence of line width variation		100
Acute Angles [Table A15: Ref. 25]	Abrupt shifts in the movement of the traced line creates an angular appearance to what are smoothly curving strokes in the model writing		98
Pen-Lift [Table A15: Ref. 26]	Location	<i>Connecting strokes</i>	21
		<i>Curved strokes</i>	20
		<i>Horizontal strokes</i>	17

Table 26: Cont'd..

Characteristic Group	Characteristic Sub Group &/or Detail		Overall Percentage of Occurrence (%)
Pen-Lift (Cont'd) [Table A15: Ref. 26]	Location (Cont'd..)	<i>Where directional changes in strokes occur</i>	12
		<i>At the completion of every stroke</i>	9
		<i>Angled strokes</i>	5
		<i>At the completion of one letter before starting the initial stroke of the next</i>	5
		<i>Mid letter</i>	5
		<i>At the completion of the loop of a letter before beginning its stem</i>	5
		<i>During down strokes</i>	4
		<i>During up strokes</i>	3
	Pen-Lifts are carelessly made	53	
	Pen-Lifts are carefully made	47	
	Writers displaying pen-lifts in their natural writing	5	
	Natural pen-lifts are included in traced writing	100	
	Writers who habitually include pen-lifts in their natural writing will increase the number of pen-lifts in their tracings	100	
Irregular Stroke Edges* [Table A15: Ref. 27]	Location	<i>Curved strokes</i>	60
		<i>Down strokes</i>	20
		<i>Flourishes</i>	10
		<i>Horizontal strokes</i>	10

* This characteristic also appears in Table 28: Characteristics Associated Specifically with Traced Forgery

Table 26: Cont'd..

Characteristic Group	Characteristic Sub Group &/or Detail		Overall Percentage of Occurrence (%)
Tremor [Table A15: Ref. 28]	Tremor Type	<i>Gross Tremor</i>	71
		<i>Fine Tremor</i>	29
	Location of Tremor	<i>Curved Strokes</i>	41
		<i>Down strokes</i>	28
		<i>Connecting strokes</i>	10
		<i>Horizontal strokes</i>	9
		<i>Up strokes</i>	7
		<i>Initial strokes</i>	2
		<i>Terminal strokes</i>	2
		<i>Angled strokes</i>	1
Hesitation [Table A15: Ref. 29]	Location of Hesitation	<i>Initial strokes</i>	28
		<i>Directional changes (including angled strokes and narrow turns)</i>	26
		<i>Curved strokes</i>	11
		<i>Down strokes</i>	10
		<i>Terminal strokes</i>	9
		<i>Connectors</i>	6
		<i>Up strokes</i>	5
		<i>At the completion of one letter before starting the initial stroke of the next</i>	1
		<i>Flourishes</i>	2
		<i>Horizontals</i>	2
	Hesitation Type	<i>Ink blot on written stroke</i>	63
		<i>Firm clear mark near or alongside stroke</i>	14
		<i>Extraneous hairline beside initial stroke</i>	10
		<i>Pivot Marks*</i>	7
		<i>Short jagged appearance to an otherwise smooth stroke</i>	6
<i>Indentation mark on or beside stroke</i>	0		

* This characteristic also appears in Table 28: Characteristics Associated Specifically with Traced Forgery

Table 26: Cont'd..

Characteristic Group	Characteristic Sub Group &/or Detail		Overall Percentage of Occurrence (%)
Retouching [Table A15: Ref. 30]	Retouching: Care of Execution	<i>Retouching is carefully made</i>	85
		<i>Retouching is carelessly made</i>	15
	Reason for Retouching	<i>To extend stroke/s</i>	46
		<i>To touch in connecting strokes</i>	39
		<i>To touch-in omitted delicate features</i>	36
		<i>To perfect strokes</i>	27
		<i>To repair the ink line</i>	21
		<i>To perfect connecting strokes</i>	15
		<i>To add shading that is consistent with the model writing</i>	12
		<i>To insert loops</i>	3
Retouching is made with strokes that move in the opposite direction to those they seek to repair		39	
Overwriting [Table A15: Ref. 30]	Overwriting: Care of Execution	<i>Overwriting is carefully made</i>	18
		<i>Overwriting is carelessly made</i>	82
	Reason for Overwriting	<i>To perfect letter formation</i>	91
		<i>To perfect connecting strokes</i>	27
		<i>To repair the ink line</i>	18
		<i>To extend stroke/s</i>	9
		<i>To obscure mistakes</i>	9
	<i>To improve the appearance of an entire word</i>	9	
Overwriting is made with strokes that move in the opposite direction to those they seek to repair		64	

Table 27: Traced Forgery – Inconsistency with the Model Writing

Characteristic Group	Characteristic Sub Group &/or Detail	Overall Percentage of Occurrence (%)
Omission in the Tracing of Fine Detail or Inconspicuous Elements Inherent to the Model	98	
Incorrect Line Direction	98	
Inconsistent Alignment	96	
Misinterpretation of Letter Forms	96	
Discrepancies of Size	60	
Discrepancies of Slant	30	
Incorporation of Individual Characteristics	9	

Table 27: Cont'd..

Characteristic Group	Sub Group/s		Overall Percentage of Occurrence (%)
Omission of Fine Detail [Table A15: Ref. 35]	Types of omission	<i>Omission of stroke sequences</i>	96
		<i>Omission of hairline strokes</i>	94
		<i>Omission of letter form detail</i>	85
	Types of omission	<i>Omission of 'i' dots</i>	76
		<i>Omission of loops</i>	16
		<i>Omission of connecting strokes</i>	4
Incorrect Line Direction [Table A15: Ref. 36]	Location	<i>Stroke ends</i>	18
		<i>Up strokes</i>	17
		<i>Down strokes</i>	16
		<i>Clockwise loops</i>	13
		<i>Anticlockwise loops</i>	10
		<i>Curves</i>	7
		<i>Cross bars</i>	5
		<i>Directional changes in the line</i>	5
		<i>Angles</i>	4
		<i>Connectors</i>	4
		<i>Flourishes</i>	1

Table 27: Cont'd..

Characteristic Group	Sub Group/s	Overall Percentage of Occurrence (%)	
Inconsistent Alignment to the Printed Line or printed box [Table A15: Ref. 37]	Tracings positioned too far to the right and too high to the printed line compared with the model writing	83	
	Tracing placed too far to the right only	11	
	Tracing placed too far to the left of the printed line	6	
	Individual whole letters are displaced in the tracing	69	
Misinterpretation of Letter Forms [Table A15: Ref. 38]	Misinterpreted letter forms written in the natural hand of the forger	10	
Discrepancies of Size [Table A15: Ref. 39]	Tracings observed to have increased in overall horizontal width	40	
	Incorrect height to width ratio observed in the tracing compared to the model it copied	20	
		<i>Increased height to width ratio</i>	100
		<i>Decreased height to width ratio</i>	0
	An abrupt diminishing of looped formations observed	20	
	Discrepancies in size observed in the traced samples imparted an unnatural, inconsistent appearance to the writing	100	

Table 27: Cont'd..

Characteristic Group	Sub Group/s	Overall Percentage of Occurrence (%)	
Discrepancies of Slant [Table A15: Ref. 40]	The slant and tilt of certain letters are observed to be difficult for the tracers to replicate	48	
		<i>Letter i</i>	12
		<i>Letter e</i>	12
		<i>Letter t</i>	24
Incorporation of Individual Characteristics [Table A15: Ref. 41]	The individual characteristics of the forger are incorporated into their tracings	9	

Table 28: Characteristics Associated Specifically with Traced Forgery

Characteristic Group	Sub Group/s	Overall Percentage of Occurrence (%)	
Visible Guidelines [Table A15: Ref. 31]	When guidelines were used to make a tracing, there was evidence present in the writing to establish this fact.	100	
	The entire guideline used to make the tracing was visible	38	
	Part of the guideline used to make the tracing was visible	62	
	Guidelines tended to be visible in the following locations	<i>Curves</i>	30
		<i>Terminal strokes</i>	30
		<i>Beginning of down strokes</i>	20
		<i>Angles</i>	10
<i>Initial strokes</i>		10	

Table 28 Cont'd..

Characteristic Group	Sub Group/s		Overall Percentage of Occurrence (%)
Over and Under Extension of Strokes [Table A15: Ref. 32]	Overall occurrence of traced samples exhibiting over &/or under extended strokes		95
	Tracings displaying over extended strokes only		57
	Tracings displaying under extended strokes only		9
	Tracings displaying both over extended and under extended strokes		34
	Strokes affected by over or under extension compared with the model writing	<i>Vertical strokes extend too far below baseline</i>	35
		<i>Flourishes extend too far</i>	24
		<i>Vertical strokes extend too high above mid zone</i>	23
		<i>Cross bars in the tracing extend too far</i>	18
		<i>Cross bars in the tracing decrease in length</i>	48
<i>Vertical strokes do not extend far enough towards or below the baseline</i>		35	
<i>Flourishes do not extend far enough below the baseline</i>	17		
Irregular Stroke Edges* [Table A15: Ref. 27]	A series of rounded indentations were apparent at the outer edge of either side of the ink line		93
	Location	<i>Curved strokes</i>	60
		<i>Down strokes</i>	20
		<i>Flourishes</i>	10
		<i>Horizontal strokes</i>	10

* See also -Table 26: Traced Forgery – Line Quality Characteristics

Table 28: Cont'd..

Characteristic Group	Sub Group/s	Overall Percentage of Occurrence (%)
Superimposition [Table A15: Ref. 33]	Tracings exhibiting poor or extremely poor superimposition	14
	The tracing of zig-zag strokes exhibits closer coincidence with the model than the tracing of curves	93
Extraneous Marks [Table A15: Ref. 34]	Superfluous marks were present in the traced samples	57
	Faint hairlines were observed throughout the traced samples	66
	Smudges were present in the traced samples	31
	Graphite smears were present in the traced samples	3
Hesitation (Pivot Marks)* [Table A15: Ref. 29]	Some tracings will exhibit hesitation in the form of pivot marks caused by the writer pausing their pen and exerting pressure on it in order to pivot the top page to see the model writing underneath. Such marks are peculiar to traced forgery and tend to be conspicuous.	7

* See also -Table 26: Traced Forgery – Line Quality Characteristics

Table 29: Deviant Writing - A Comparison of Degenerated Line Quality Characteristics

Characteristic Group	Percentage of Occurrence	Percentage of Occurrence	Percentage of Occurrence	Overall Percentage of Occurrence for all Forms of Deviant Writing
	DISGUISED Writing	TRACED Writing	SIMULATED Writing	
Degenerated Line Quality	100%	100%	97%	98
Speed and Pressure Variation*	92	99	97	96
Blunt Ends	73	100	97	90
Acute Angles in Curved Strokes	68	98	97	88
Pen-lift	45	97	52	65
Hesitation	50	88	55	64
Tremor	8	93	86	62
Retouching	32	58	17	36
Overwriting	32	19	9	20

* In the study of simulations (Lafone, 2005), the characteristics of pressure variation and blunt ends were not included under the heading of Degenerated Line Quality, as they are in the study of disguised and traced handwriting. However, the findings relating to these characteristics in the earlier study have been assimilated in the above table with those it found for degenerated line quality to enable more meaningful comparisons to be made between the different types of deviant handwriting. See also section 2.2.2

Table 30: Deviant Writing - A Comparison of Characteristics in Common (caused by the process of deviant writing)

Characteristic Group	Percentage of Occurrence	Percentage of Occurrence	Percentage of Occurrence	Overall Percentage of Occurrence for all Forms of Deviant Writing
	DISGUISED Writing	TRACED Writing	SIMULATED Writing	
Degenerated Line Quality	100%	100%	97%	98
Inconsistent Baseline to model	n/a	96	100	98
Omission of Fine Detail in forgery from model writing	n/a	98	62	80
Discrepancies in size to the model writing	n/a	45	98	75
Misinterpretation of Letter Forms in the model creates errors in the forgery	n/a	96	52	74
Discrepancies in slant to the model	n/a	30	97	62
Incorporation of the Forger's Individual Characteristics	97	9	35	47

* To be read in conjunction with Table 29: Deviant Writing - A Comparison of Degenerated Line Quality Characteristics

Table 31: Disguised and Traced Writing – A Summary of Findings

Ref. No.	Characteristic Group	Sub Group	Finding	Section No.	Page No.
DISGUISED WRITING: Inconsistency					
Striking inconsistency may be regarded as one of the major defining characteristics of disguised writing. It is to be expected that a deliberately modified natural writing will exhibit considerable variation in three or more of its writing features. Significant inconsistency tends to impart an erratic appearance to the writing which immediately renders it as suspicious and probably disguised.					
1a	Connecting Stroke Inconsistency	The product of deliberate alteration	Attempts to disguise connecting strokes will typically be unsuccessful. Strokes will tend to be produced with awkwardly made movements and varying slants and will be frequently retouched. Inconsistency will commonly occur as writers revert to habitual ways of forming their connecting strokes. Constant changes in the connecting strokes will impart an unnaturally disordered appearance to the writing.	6.2.1.8.2	246
1b		As a by-product of other disguises	The process of disguise will often affect the slant and movement of connecting strokes, even when these have not been deliberately altered. Awkwardly made movements and inconsistent slant may occur, especially in the disguise of lengthier texts.	6.2.1.8.4	247
2	Inconsistent Initial and Terminal Strokes	The product of deliberate alteration	Marked inconsistency will occur in the initial and/or terminal strokes when these have been disguised as writers revert to habitual methods of forming these strokes. Initial strokes will typically be affected more frequently than terminal strokes and any assumed alterations will often be touched in only after the letter/s or word/s concerned have been completed.	6.2.1.5.1	234
3a	Letter Form Variation	The product of deliberate alteration	Regardless of the length of writing involved, writing that has been disguised by form alteration will exhibit frequent and inconstant changes in the design and structure of its letters as letter forms revert back to that which is natural for the forger. Assumed form inconsistency will be found throughout disguised texts, but will frequently be observed from the outset of the writing. Constant variation in letter form will impart an uncontrolled appearance to the writing.	6.2.1.3.2	230

Table 31: Cont'd..

Ref. No.	Characteristic Group	Sub Group	Finding	Section No.	Page No.
3b	Letter Form Variation (Cont'd..)	As a by-product of other disguises	Letter form inconsistency, particularly in lengthier texts, will tend to occur in writing that has been disguised by means other than form alteration. Unusual or grotesque letter forms will tend to occur which will be incongruous with other writing in the script. Such inconsistency will impart an uncontrolled, unnatural appearance to the writing.	6.2.1.3.4	231
4	Inconsistency Due to the Use of the Non-Dominant Hand	The product of deliberate alteration	Handwriting that is disguised by means of the unaccustomed hand will tend to display errors in the ink line that are more abundant and considerably more conspicuous than those occurring in texts disguised by alternative means. The overall effect of so much variation will typically create a pictorial appearance that is strikingly disjointed and arrhythmic. Even under the most cursory of examinations, such writing cannot be considered as in any way natural and will contain numerous features that are indicative of its having been written slowly and hesitantly. It will evidence gross distortion, erratically formed connecting strokes and cross-bars, tremulous strokes, and fine hairlines that bisect letters and words. Such writing will also tend to possess looped formations that move in an awkward anti-clockwise direction and possess an ink line that will be angular or zigzagged in appearance. Commonly, writers who disguise their writing using their opposite hand will fail to camouflage their idiosyncratic writing habits and, provided that sufficient and suitable exemplars are available to the examiner for comparison, these will enable the handwriting examiner to provide a strong opinion as to authorship.	6.2.1.14.1	258
5	Special Character Inconsistency	The product of deliberate alteration	Attempts to disguise the special characters in writing will typically be unsuccessful. Commonly, modifications will only be made to the 'i' dots, while other special characters maybe overlooked. Any modifications that are made will tend to be inconsistent as writers revert to habitual methods of forming these characters.	6.2.1.11.1	251

Table 31: Cont'd..

Ref. No.	Characteristic Group	Sub Group	Finding	Section No.	Page No.
6	Inconsistency Due to Feigned Writing Care	The product of deliberate alteration	Writings that are disguised by feigned carelessness will tend to exhibit clear evidence of having been written intermittently at great speed, but will be combined with conspicuous marks of hesitation. In addition, the occurrence of gross letter distortion and/or inconstant character sizing will generally result in a writing that is distinctly atypical. Such an appearance in questioned writing should be regarded as strongly indicative of disguise.	6.2.1.15.1	261
7	Numeral Inconsistency	The product of deliberate alteration	Attempts to disguise the numerals in a text will typically be unsuccessful. Inconsistent designs will be produced and the writer will frequently revert to habitual ways of writing numbers. Numerals occurring in dates and/or times will tend to remain entirely undisguised or will exhibit alterations only to the numbers occurring at the beginning of the date and/or time	6.2.1.9.1	249
8a	Inconsistent Text Arrangement	Inconsistency of Lateral & vertical spacing: The product of deliberate alteration	Marked inconsistency will be observed in the lateral and vertical spacing of extended text writing when these features have been deliberately modified as the writer will be unable to maintain their disguise. Writers will frequently revert to natural methods of lateral spacing, but vertical spacing will tend to be generally haphazard. Spacing inconsistency will result in a writing appearance that is chaotic and unnatural	6.2.1.7.2	239
8b		Inconsistency of Lateral & vertical spacing: A by-product of other disguises	Writing that has been disguised by means other than an alteration of spacing will sometimes display obvious and persistent inconsistency in the spacing between letters and words, irrespective of the length of the writing involved or the disguise method used. In extended texts, such inconsistency will tend to be accompanied by the more even line spacing that is generally characteristic of the forger's natural writing.	6.2.1.7.3	240

Table 31: Cont'd...

Ref. No.	Characteristic Group	Sub Group	Finding	Section No.	Page No.
8c	Inconsistent Text Arrangement Cont'd..	Text arrangement on envelopes: The product of deliberate alteration	The distinctive way in which writers arrange the writing on an envelope will tend to remain unmodified during disguise. Where attempts are made to alter the arrangement of their writing, this will tend to be inconsistent as frequent reversion will be made to the writer's habitual methods of positioning their text.	6.2.1.7.5	241
8d		Baseline shifts: As a by-product of other disguises	Inconsistencies in the baseline will often occur in writing that has been disguised by means other than baseline alteration. The direction of the line will become haphazard or will be gross exaggerations of the writer's usual baseline. In extended text it will be common for the baseline to ascend upwards to the right, especially if back slant has been adopted as the disguise. Extreme variations in the baseline of a signature or extended text will produce an abnormally erratic appearance which should immediately render the writing suspicious and probably disguised.	6.2.1.7.7	244
9a	Writing Slant Variation	The product of deliberate alteration	It is to be expected that when writing slant is deliberately altered, a reversion to the writer's habitual slope will be evidenced during the script or signature. When the writing is lengthy, reversion can be expected in individual letters and words as well as in entire sections of text. Particular attention should be given to any double letters in a script, especially where their slope is found to vary from the overall slope of the rest of the writing, as this can serve as an important indicator of disguise and provide the examiner with valuable comparison material should an attempt be made to identify the author.	6.2.1.1.2	215
9b		As a by-product of other disguises	Writing that has been disguised by means other than an alteration of slant will often display a writing slope that will shift erratically between forehand, backhand and vertical slopes before returning to the writer's habitual slope	6.2.1.1.4	216
9c		Overall consequence of slant inconsistency	When the writing in a questioned document is unusually untidy and erratic and the appearance can be attributed directly to a constant shift in writing slant, this can serve as persuasive evidence that the writing has been disguised.	6.2.1.1.6	218

Table 31: Cont'd..

Ref. No.	Characteristic Group	Sub Group	Finding	Section No.	Page No.
10a	Inconsistent Writing Speed and Pressure*	The product of deliberate alteration	Contradictory signs of speed will typically be observed in texts that have been disguised by means of altering natural writing speed, regardless of the length of the text involved. Writing speeds will revert to that which is natural for the writer and this will tend to occur towards the end of the disguised text. Any change in writing speed will result in an unnaturally erratic and untidy appearance, and extreme accelerations in speed will lead to writing that is illegible in parts.	6.2.1.4.2	233
10b		As a by-product of other disguises	It is to be expected that disguised writing will generally be made more slowly than genuinely made writing and will display less contrasting pressure.	6.2.3.1.1	264
11	Inconsistent Upper and Lower Extender Strokes	The product of deliberate alteration	It is likely that marked inconsistency will be observed in the upper and/or lower extenders when these have been disguised. Inconsistency in lengthier texts will tend to occur as writers revert to habitual methods of forming these strokes; often, when the upper and/or lower extenders occur within a word, these will remain undisguised. In signature disguise, reversions to habitual methods of forming these strokes will typically not occur, but inconsistencies will continue to be present as the writers fail to replicate their new strokes uniformly.	6.2.1.6.1	236
12a	Writing Size Variation	The product of deliberate alteration	It is to be expected that when writing size is deliberately altered the newly assumed size will not be maintained. Haphazard variations in letter size will occur and will often be so extreme that the affected characters will appear incongruous with others appearing in the same text. Inconsistency in lengthier texts will affect not only individual letters, numbers and complete words, but also entire sections of text. Letter pairs will tend to remain undisguised, even when the sizes of other letters appearing in the same word are disguised.	6.2.1.2.2	222

* This feature also appears under the heading of Degenerated Line Quality

Table 31: Cont'd...

Ref. No.	Characteristic Group	Sub Group	Finding	Section No.	Page No.
12b	Writing Size Variation (Cont'd..)	As a by-product of other disguises	Unnatural fluctuations in writing size will tend to occur in disguises where no deliberate modification of the writer's natural writing size has been attempted. When altered form is employed as a disguise method, longer texts will tend to increase in overall size when compared with the writer's natural hand, while disguised signatures will tend to decrease in size. When disguises other than form and size have been used, an enlargement in writing size will also occur in the disguise of lengthier texts. Such size fluctuations will tend to impart a noticeably erratic and uncontrolled appearance to the writing.	6.2.1.2.4	225
13	Proportional Inconsistency	As a by-product of other disguises	Occasional erratically proportioned letters may sometimes be observed in disguised writing. Although this will occur rarely, several instances of this feature in a questioned text should alert the examiner that the writing has been unnaturally made	6.2.1.10.1	250
14	Cross-Bar Stroke Inconsistency	As a by-product of other disguises	Disguised writing will often display obvious inconsistency in its cross-bar strokes. These will tend to be awkwardly made and will become wavy, zigzagged or curved in appearance and may be formed differently at each separate occurrence in the same text. This is a characteristic that appears to be peculiar to disguise.	6.2.1.12.1	253
15	Handprinting Inconsistency	The product of deliberate alteration	Handprinting disguise will tend to revert to that which is natural for the writer, except when handprinting is used to disguise a signature, in which case the writing will commonly remain within the limits of the writer's natural variation.	6.2.1.13.1	253

Table 31: Cont'd..

Ref. No.	Characteristic Group	Sub Group	Finding	Section No.	Page No.
DISGUISED WRITING: Degenerated Line Quality					
It is to be expected that disguised writing will exhibit evidence of poor line quality. The smooth ink line that is generally characteristic of genuinely made writing will become noticeably uneven as it is affected by instances of many or all of the features that are indicative of a writing that has been made slowly and hesitantly. In particular, a lack of speed and pressure will be evident, blunt ends will be present and curved strokes will become more angular in appearance. Instances of overwriting, retouching and pen-lift will occur frequently in extended disguised texts, but less frequently in signature disguise, while tremulous strokes will rarely occur regardless of the length of the writing involved					
10a	Inconsistent Writing Speed & Pressure	The product of deliberate alteration	Contradictory signs of speed will typically be observed in texts that have been disguised by means of altering natural writing speed, regardless of the length of the text involved. Writing speeds will revert to that which is natural for the writer and this will tend to occur towards the end of the disguised text. Any change in writing speed will result in an unnaturally erratic and untidy appearance, and extreme accelerations in speed will lead to writing that is illegible in parts.	6.2.1.4.2	233
10b		As a by-product of other disguises	It is to be expected that disguised writing will generally be made more slowly than genuinely made writing and will display less contrasting pressure.	6.2.3.1.1	264
16	Blunt Ends	As a by-product of other disguises	In the process of disguise, the finely tapered strokes that are generally indicative of unrestrained natural writing will tend to become clubbed or blunted in appearance. More commonly, blunt ends will be found on the initial and terminal strokes.	6.2.3.5.1	277
17	Acute Angles in Curved Strokes	As a by-product of other disguises	The smoothly curving strokes that are generally found in natural writing will frequently become more angular as a direct consequence of the disguising process. Curves may be reproduced as a series of short, straight lines, or where a single change in the stroke direction has occurred, the curve may become a single sharp point.	6.2.3.7.1	281

Table 31: Cont'd..

Ref. No.	Characteristic Group	Sub Group	Finding	Section No.	Page No.
18	Hesitation	As a by-product of other disguises	Marks of hesitation, where the pen has paused on the paper, will commonly be found in disguised extended text. This characteristic will also be observed in signatures that have been disguised, but will occur less frequently. In lengthier texts, hesitation marks will tend to take the form of a firm clear mark near or alongside a written stroke, while in disguised signatures they will more often appear as an obvious ink blot on the written stroke. Hesitation marks in all forms of disguised writing will tend to be found at the beginning of down strokes.	6.2.3.3.1	272
19	Pen-Lift	As a by-product of other disguises	Disguised writing will frequently display numerous indications in its written line that the pen has been lifted from and returned to the paper. Pen-lift will also be encountered in signature disguise, but the frequency of occurrence will be much lower. Fraudulent pen-lift will be observed in places where their presence interrupts what would naturally be a continuous flow of writing; more commonly, evidence of fraudulent pen-lift will be found in the connecting strokes between letters and words and in curved strokes	6.2.3.4.1	275
20	Retouching and Overwriting	As a by-product of other disguises	<p>Disguised extended texts will commonly exhibit a large number of delicately retouched or overwritten strokes, and these will frequently move in the opposite direction to the original stroke they seek to repair. Instances of retouching will occur much less frequently in disguised signatures, whereas overwriting may not be observed at all. The carefully retouched or overwritten strokes observed in disguise will tend to differ from that found in natural writing which is generally made more carelessly. More commonly, retouching and/or overwriting will occur in curved strokes but may also be found in down strokes and punctuation marks.</p> <p>The presence of retraced and/or patched strokes in a questioned writing can serve to distinguish unnaturally made writing from that which is genuine, and when such evidence is found in great quantity, it should be regarded as strongly indicative of disguise.</p>	6.2.3.2.4	269

Table 31: Cont'd..

Ref. No.	Characteristic Group	Sub Group	Finding	Section No.	Page No.
21	Tremor	As a by-product of other disguises	Tremulous strokes occur only very rarely in disguised writing, but when they do, they will tend to be conspicuous and will occur more commonly in the curving strokes.	6.2.3.6.1	279
DISGUISED WRITING: Identifying the Author of a Disguised Writing					
22	Disguised writing will typically incorporate writing features that fall within the limits of the writer's natural variation. In the large majority of disguised samples the rate of occurrence was very high, and for most of these (89%) it was possible to associate the disguised writing with the writer. This suggests that provided that suitable exemplars from a suspected writer are available, it will be possible, more often than not, for the author of a disguised writing to be identified.			6.2.6.1.1	292

Table 31: Cont'd..

Ref. No.	Characteristic Group	Sub Group	Finding	Section No.	Page No.
TRACED WRITING: Degenerated Line Quality					
<p>It is to be expected that a traced signature will invariably exhibit a very poor line quality. The smooth ink line that is generally characteristic of a genuine signature will become noticeably uneven as it is affected by numerous instances of many or all of the features that are indicative of a writing that has been made slowly and hesitantly. Degenerated line quality may be regarded as a chief determinant of traced forgery</p>					
23	Blunt Ends	As a by-product of the tracing process	A high prevalence of strokes possessing blunted ends is to be expected in a traced signature. Often these will assume a clubbed appearance, although a fishtail form may sometimes be encountered. Blunt ends will often occur on every stroke in the signature and is a very strong indicator of traced forgery.	6.4.1.5.1	311
24	Speed and Pressure Variation	As a by-product of the tracing process	A traced signature will generally differ significantly from the model writing it copies by exhibiting palpable signs of having been produced very slowly and with a consistently heavy pen pressure. This will be indicated by thicker, darker ink lines with no variable shading.	6.4.1.1.1	297
25	Acute Angles	As a by-product of the tracing process	It is to be expected that a traced signature will exhibit abrupt shifts in the ink line that will impart a definite angled appearance to curved strokes that in natural writing would tend to be written smoothly.	6.4.1.7.1	314
26	Pen-Lift	As a by-product of the tracing process	A traced signature will generally exhibit numerous indications in its written line that the pen has been lifted from and returned to the paper. Evidence of unnatural pen-lift can be expected in places where its presence interrupts what tends to be a continuous flow of writing in handwriting that has been genuinely made; commonly, pen-lifts will occur in connecting, curved and/or horizontal strokes. Numerous and unnatural pen-lift in questioned writing may be considered a strong indicator that the writing has been traced.	6.4.1.4.1	308

Table 31: Cont'd..

Ref. No.	Characteristic Group	Sub Group	Finding	Section No.	Page No.
27	Irregular Line Edges*	As a by-product of the tracing process	In the process of tracing, the smooth outer edges of a written stroke, a feature generally associated with unrestrained natural writing, will tend to become irregular or ragged in appearance. Ragged line edges may be rounded or serrated in appearance depending on the pen that is used to make the tracing. Any stroke may be affected in this way, but irregular line edges will most commonly be observed in curved strokes	6.4.1.8.1	316
28	Tremor	As a by-product of the tracing process	Traced forgeries will generally exhibit a marked deterioration in the writing line in the form of conspicuous oscillations, or tremor; these will be visible with or without the benefit of magnification. Tremor will commonly occur in curving strokes and down strokes.	6.4.1.6.1	313
29	Hesitation**	As a by-product of the tracing process	Traced signatures will tend to contain more marks of hesitation than either disguised writing or freehand simulated signatures. Commonly hesitation marks will be found on the initial stroke of a signature where directional changes take place in the ink line, and in locations that would in natural writing typically be continuous, such as during curved or connecting strokes. Some tracings will exhibit pivot marks caused by the writer pausing their pen and exerting pressure on it in order to pivot the top page to see the model writing underneath. Such marks are peculiar to traced forgery and tend to be conspicuous.	6.4.1.3.1	304
30	Retouching and Overwriting	As a by-product of the tracing process	A traced forgery will tend to be repaired more frequently than any other written forgery. Retouching will tend to be applied delicately, whereas overwriting will often be performed carelessly; in both cases repairs or patching will often be made with the ink line moving in the opposite direction to the original stroke they seek to correct or perfect. It will sometimes be the case that looped formations will be touched in after the general form or outline of the tracing has been completed.	6.4.1.2.2	302

* This feature appears under the heading - Degenerated Line Quality (Table 26: Traced Forgery – Line Quality Characteristics) & Characteristics Associated Specifically with Traced Forgery (Table 28).

**Pivot Marks also appear below under the heading Characteristics Associated Specifically with Traced Forgery.

Table 31: Cont'd..

Ref. No.	Characteristic Group	Sub Group	Finding	Section No.	Page No.
TRACED WRITING: Characteristics Associated Specifically with Traced Forgery					
31	Visible Guidelines	As a by-product of the tracing process	When guidelines have been used to create a traced forgery, there will invariably be evidence present in the tracing that can establish this fact, regardless of the type of guideline employed. Entire guidelines will sometimes be observed to run alongside the ink line for the duration of the signature, but where only a partial guideline is observable, this will commonly occur on curved strokes, terminal strokes or at the very beginning of down strokes. Guidelines may also be observed on angled strokes and initial strokes, but much less frequently. Guidelines will typically be visible with or without the aid of magnification.	6.4.3.1.1	319
32	Over and Under Extension of Strokes	As a by-product of the tracing process	A proliferation of strokes of varying lengths will often be apparent in a traced forgery. The presence of irregular stroke lengths in a questioned writing will not on its own proclaim the writing to be traced, but in conjunction with other corroborative evidence, will serve as a strong indication that tracing has occurred.	6.4.8.1.1	330
27	Irregular Line Edges*	As a by-product of the tracing process	In the process of tracing, the smooth outer edges of a written stroke, a feature generally associated with unrestrained natural writing, will tend to become irregular or ragged in appearance. Ragged line edges may be rounded or serrated in appearance depending on the pen that is used to make the tracing. Any stroke may be affected in this way, but irregular line edges will most commonly be observed in curved strokes	6.4.1.8.1	316

* This feature appears under the heading of Degenerated Line Quality (Table 26: Traced Forgery – Line Quality Characteristics) & Characteristics Associated Specifically with Traced Forgery (Table 28).

Table 31: Cont'd..

Ref. No.	Characteristic Group	Sub Group	Finding	Section No.	Page No.
33	Inconsistent Superimposition	As a by-product of the tracing process	It is to be expected that most traced forgeries will show a close correspondence with the strokes of its model writing, but they will never be an exact duplication. In particular, curved strokes will reveal less coincidence with those in the model writing.	6.4.4.1.1	321
34	Extraneous Marks	As a by-product of the tracing process	Traced signatures will frequently display superfluous marks. Smudges may be present where the forger's hand has rubbed over writing that has already been completed, and/or graphite smears may be observed when a graphite sheet has been used to create the tracing. More commonly, fine hairlines will be found in close proximity to the writing, or will be observed to bisect individual strokes and/or letters	6.4.10.1.1	333
29	Hesitation (Pivot Marks)*	As a by-product of the tracing process	Some tracings will exhibit pivot marks caused by the writer pausing their pen and exerting pressure on it in order to pivot the top page to see the model writing underneath. Such marks are peculiar to traced forgery and tend to be conspicuous.	6.4.1.3.1	304

* This feature appears in Table 26: Traced Forgery – Line Quality Characteristics, & Table 28: Characteristics Associated Specifically with Traced Forgery

Table 31: Cont'd..

Ref. No.	Characteristic Group	Sub Group	Finding	Section No.	Page No.
TRACED WRITING: Discernible Inconsistency with Model Writing					
35	Omission of Detail	As a by-product of the tracing process	A traced writing will typically contain less detail than the model writing it copies and will typically omit more detail than will be observed in a simulated signature. The fine detail and inconspicuous elements that are integral to the model writing such as stroke sequences, hairline strokes, letter form detail and 'i' dots will commonly be omitted from the tracing. Looped formations and/or connecting strokes may also be excluded, but far less frequently.	6.4.5.1.1	323
36	Incorrect Line Direction	As a by-product of the tracing process	Traced writing will typically contain strokes that move in the wrong or opposite direction to that of the corresponding strokes contained within the model writing. Commonly, this characteristic will occur in stroke ends, in the up and down strokes and in the clockwise and anticlockwise loops. The presence of strokes that move in the wrong direction to the genuine writing should be regarded as strongly indicative of traced forgery.	6.4.7.1.1	327
37	Inconsistent Alignment	As a by-product of the tracing process	A questioned signature that departs significantly from the known habits of the genuine signatory in terms of positioning and baseline alignment is likely to be a forgery; moreover, where individual letters are observed to have shifted abruptly in the writing, there is a high likelihood that the writing has been traced.	6.4.9.1.1	331
38	Mis-interpretation of Letter Forms	As a by-product of the tracing process	During the process of tracing, the forger will frequently misinterpret letter forms that occur in the model writing and will incorporate erroneous characters in their tracing. Sometimes, an incorrect character will be formed in the forger's natural manner. Owing to the nature of the tracing process, any tracing may exhibit misinterpreted letter forms, but commonly, it will occur when the model signature is lengthy and contains characters that are not clearly identifiable.	6.4.6.1.1	325

Table 31: Cont'd..

Ref. No.	Characteristic Group	Sub Group	Finding	Section No.	Page No.
39	Discrepancies of Size	As a by-product of the tracing process	It will frequently be found that a traced signature will differ in size from the model writing it copies and that disparities of size will tend to occur in the overall horizontal length. Moreover, inconsistencies in size will lead to an appearance that is distinctly unnatural and one that can alert the examiner to the possibility of forgery	6.4.11.1.1	336
40	Discrepancies of Slant	As a by-product of the tracing process	A traced forgery will sometimes fail to follow the direction of writing slant exhibited in the model. Slant deviation will most commonly occur in the down strokes and particularly in the lower-case letters 'i' and 't'. The slant and tilt of the letter 'e' may also be incorrect. Slant deviation will not on its own proclaim the writing to be traced, but in conjunction with other corroborative evidence, it can serve as a strong indicator that the writing has been unnaturally made.	6.4.12.1.1	339
TRACED WRITING: Identifying the Author of a Traced Writing					
41	Traced signatures will only rarely contain the individual characteristics of their writer, but when they do, these will typically involve idiosyncratic pen lift and the incorporation of habitual letter forms. Such characteristics will not, however, appear in sufficient number to enable the tracing to be reliably linked with the tracer.			6.4.13.1.1	340

NOTES

ⁱ See, for example, *The Trial of Algernon Sydney, in the King's Bench, For High Treason* [1683] 35 Cha. II, 9 Howell, 818. In: Phillipps (1826) pp.87-117. At his trial, the Earl of Essex, Algernon Sydney, was accused and subsequently found guilty of High Treason. The case against Sydney relied heavily upon the determination of authorship of certain incriminating documents. Witnesses were 'called for the purpose of proving the papers to be in Sydney's handwriting' (cited in Phillipps, p.97). Sydney 'was executed [...] on the single witness of that monster[...] Lord Howard of Escrick, and some sheets of paper taken in Mr. Sydney's study, pretended to be written by him, but not prov'd..' (cited in Evelyn, 1871, p.452). See also *Goodtitle dem. Revett v. Braham*, in which two Post-Office clerks were allowed to testify due to their 'knowledge of handwriting in general'. The Judge, Lord Kenyon, in giving his reasons for admitting the evidence, stated that each expert's 'science, his knowledge, his habit, all entitle him to say, I am confident it is a feigned hand.' (cited in Hinton, 1919, p.798). This case is considered the first in which witnesses with specialist knowledge of handwriting were allowed and whose testimony was based on a comparison of the questioned writing with handwriting exemplars. Such evidence was not typically allowed in the Courts until the Reform Act of 1854 (Risinger et al., 1989, p.755; Huber and Headrick, 1999, p.4).

ⁱⁱ Enacted in 539 A.D. For a translation of the Justinian Code, see Scott (1932).

ⁱⁱⁱ The Common Law Procedure Act 1854 stated that a '[c]omparison of a disputed writing with any writing proved to the satisfaction of the judge to be genuine shall be permitted to be made by witnesses; and such writings, and the evidence of witnesses respecting the same, may be submitted to the Court and jury as evidence of the genuineness, or otherwise, of the writing in dispute' (Great Britain. *Common Law Procedure Act 1854*: c. 125 (Regnal. 17 and 18 Vict) § 27).

^{iv} See, for example, Giles (2004).

^v See, for example, *State v. Hauptmann*, in which the identification of Richard Hauptmann as the writer of a series of anonymous letters formed a large part of the evidence against him which resulted in his conviction of the kidnapping and murder of the baby son of Colonel Charles A. Lindberg. Other notable cases include *R v. McKenny & Ors*; *R v. Maguire*; *R v. Harold Frederick Shipman*. There are also lesser known court cases in which handwriting analysis has played a large part. See, for example, Britten (2006) who reports the case of a clairvoyant who forged the will of a pensioner's dead husband. See also the *Guardian* (2004), which reports the case of Richard Davis, convicted of forging his grandmother's will and signature, and *The Mirror* (2008) which reports the case of an organist who forged her dead boyfriend's will.

^{vi} Risinger et al. (1989) examined one published test undertaken by Fred E. Inbau (1939) and five unpublished reports by the Forensic Sciences Foundation made between 1975 and 1987. For a summary of these tests see Risinger et al. (1996) pp.41-47.

^{vii} Until 1993, the Frye rule or standard had been the guiding principle for the admissibility of expert scientific evidence. In *Frye v. United States* a debate ensued as to whether evidence derived from a systolic blood pressure deception test (a precursor to the polygraph machine) was admissible. The Frye rule determined that expert scientific evidence was admissible so long as it was generally accepted by the relevant scientific community (Pyrek, 2007, p.343; Keane, 2008, p.539). The Court of Appeals for the District of Columbia stated, 'Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs' [*Frye v. United States*, 54 App.D.C., 47, 293 F., at 1014. (1923)]. On this basis, the expert evidence was ruled inadmissible. (See generally *ibid.* at 1013, 1014).

^{viii} Under the Federal Rules of Evidence, if expert testimony involving 'scientific, technical, or other specialized knowledge will assist the trier of the fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise, if (1) the testimony is based on sufficient facts or data (2) the testimony is the product of reliable principles and methods and (3) the witness has applied the principles and methods reliably to the facts of the case' (Fed. R. Evid. 702).

^{ix} See also Kiely (2006) pp.16-17.

^x In Justice Breyer's opinion for the United States Supreme Court, he wrote, 'The Daubert 'gatekeeping' obligation applies not only to 'scientific' testimony but to all expert testimony. Rule 702 does not distinguish between 'scientific' knowledge and 'technical' or 'other specialized' knowledge, but makes clear that any such knowledge might become the subject of expert testimony. It is the Rule's word 'knowledge' not the words (like 'scientific') that modify that word, that establishes a standard of evidentiary reliability' [U.S. Supreme Court, *Kumho Tire Co. v. Carmichael*, United States Reports, vol. 526, pp.137-159 (1999)]

^{xi} See for example *U.S. v. Saelee*; *U.S. v. Lewis*; See also: *U.S. v. Hernandez*; *U.S. v. Rutherford*; *U.S. v. Hines*; *U.S. v. Van Wyk*, cases in which handwriting testimony was limited to the pointing out of similarities and differences between the questioned writing and exemplars.

^{xii} See also, Moriarty and Saks (2005) 'Handwriting identification [...] is the oldest of the forensic sciences, having first been offered, and sometimes admitted, in American courts before the middle of the nineteenth century' (p.21).

^{xiii} See for example Judge Michael's dissent in the case of *US v. Crisp*, 324 F.3d 261 (4th Cir.), cert. denied, 540 U.S. 888, pp.15-30 (2003) in which he questions the validity of admitting to court the testimony of fingerprint and handwriting experts. Although Judge Michael frequently refers to fingerprint testimony, his other comments make clear that his sentiments apply equally to the testimony of handwriting experts.

^{xiv} See also: *R v. Pedder*; *R v. Luttrell & Ors*; *R v. McIlkenny & Ors*; *R v. Maguire & Ors*. Pamplin (2004) gives brief descriptions of the *R v. Pedder* and *R v. Luttrell* cases (p.1771). See also Shirley McKie's trial for perjury (Great Britain. The Scottish Parliament, 2007).

^{xv} Also cited in Great Britain. House of Commons Science and Technology Committee, 2005, p.76.

^{xvi} See also Redmayne (2001), pp.125-126.

^{xvii} Mr Brokenshire made the announcement that the Forensic Science Service would close in a written ministerial statement to the House of Commons and the House of Lords on Tuesday 14th December, 2010.

^{xviii} This claim is made by the Forensic Science Service in their mission statement: available online at: <http://www.forensic.gov.uk/html/company/>. The FSS currently handles 60% of the forensic services market, including forensic handwriting identification services (Wright, 2010. See also BBC News, 2010, para. 16).

^{xix} Also quoted in Great Britain, The Law Commission (2009) p.46, footnote 113.

^{xx} Professor Jeremy Horder is quoted in the Law Commission's Press Release (2009) which related to the Law Commissions' Consultation Paper 190, (2009).

^{xxi} It should be noted that the *CSI-effect* is not a universally accepted phenomenon. Pyrek (2008) asserts that much of the information about the phenomenon is based on no more than anecdotal information (pp.399-400).

^{xxii} For a discussion of the *CSI-effect*, see Thomas (2006).

^{xxiii} Great Britain, The Law Commission (2009) makes explicit reference to the way in which the admissibility of the testimony of a Forensic Document Examiner should be tested. They state that '[...] the reliability of an expert witness's testimony on forensic document examination (to determine whether or not a document is a forgery) would be determined on the basis of, amongst other things, the witness's experience, the number of standard points of comparison used and a detailed description of the process by which the expert reached his or her opinion' (p.57).

CHAPTER 1 – DISGUISED HANDWRITING

^{xxiv} Saudek (1928), Kropinak (1965), Regent (1979) and Halder-Sinn and Wegener (1992), have all examined the effectiveness of specific methods of disguising handwriting and have reported the characteristics that these produced, albeit not always in great depth. Saudek has also examined the difficulty of executing specific disguise methods and has tabulated any resulting characteristics. However, it is important to note that Saudek was writing from the perspective of an experimental graphologist rather than as a forensic handwriting examiner. In the early years of the twentieth century much of the experimental work that was conducted in the field of handwriting examination grew out of the, then, relatively new subject of graphology: a school of thought that links the psychological and the graphological processes. The study of graphology was borne out of the belief that a person's psychological character can be established through the study of the individual features inherent in their handwriting. Most forensic handwriting examiners categorically dismiss graphology, but Mansfield (1943) accepts that some experimental work specifically conducted 'to help graphological character-readers,' has produced findings that 'prepared a good foundation' for the study of disguised writing in particular, and the overarching, more scientific discipline of forensic handwriting analysis in general (p.24). However, the latter half of the 20th century was spent trying to separate forensic handwriting examination from graphology, which is generally considered to be a 'pseudo-science' with no claim to the 'accepted scientific method' whereas, '[q]uestioned document methodology has been designed as a scientific procedure with one ultimate customer - the court' (Levinson, 2002, p.56).

^{xxv} See for example, Harrison (2002) where simulation is categorized as a form of disguise (p.753). See also Hayes (2006) who states that '[s]ometimes there are attempts at mimicking another person's writing in which case the disguise is made even more difficult, as normal writing habits must be covered and foreign ones simultaneously adopted' (p.160).

^{xxvi} Robertson is here echoing Osborn (1929) who wrote that '[a] writing that is [...] disguised [...] is one in which the writer seeks only to hide his own personality without assuming that of any other particular person' (p.17).

^{xxvii} See Lafone (2005) for a detailed study of simulated signatures.

^{xxviii} This comment, made on 22 October, 1904 by Sir Forrest Fulton, the presiding judge at Beck's first trial in 1896, was made to the committee that was appointed by the Secretary of State to inquire into the case of Mr Beck. The proceedings of the committee, which were presided over by Sir Richard Henn Collins, were reported in *The Times* (1904a-d). The subsequent Report of the Committee of Inquiry into the Case of Mr. Adolf Beck (London 14 November, 1904) was reproduced in *The Times* (1904e) p.6.

^{xxix} George R. Simms, in his *Daily Mail* article championing Beck's cause, wrote 'I have been careful to keep to the main issue, and have refrained from examining the side issues, some of which reveal most lamentable features in connection with our criminal procedure' (Cited in Maybrick, (1904, p.160).

^{xxx} Mr C.F. Gill, counsel for the defence in 1896, made this comment on 20 October, 1904, in his statement to the Committee of Inquiry (1904). See note xxviii, sentence 2 above.

^{xxxi} The presiding chairman of the committee, Sir Richard Henn Collins, wrote that '[Mr Gill] had abundant evidence to prove that Mr. Beck could not have been the criminal of 1877 because in that year and for some years afterwards [until 1884] he was in South America' (p.6). See also *The New York Times* (1904) in which it was reported that, '[...]three witnesses – one of them a Gentleman of the Chamber of the King of Denmark and a personal friend of Beck-came to court prepared to swear that the unfortunate Norwegian was in Lima, Peru, while John Smith was picking oakum in prison!' (p.SM2).

^{xxxii} In summing up the explanation given by the counsel for the defence of how they had intended to formulate their case, Sir Richard Henn Collins said: 'In other words your defence was that Beck was not the man who had committed the crime, and the means by which you could establish that-the only means open to you then-were by showing that the crimes of 1877 and the crimes alleged against Beck were committed by the same person, and as Beck could not have committed the first therefore he did not commit the second?' (*The Times*, 1904b, p.9).

^{xxxiii} See also Irving, 2008, p.13.

^{xxxiv} A formal minute from Beck's first trial in 1898, quoted in the Report of the Committee of Inquiry and reproduced in *The Times*, 1904e, states that the '[p]risoner's counsel tried to raise the question of the prisoner's identity with [John] Smith in the course of his trial on the specific charges of fraud but the Common Serjeant [sic] ruled that it was irrelevant (Sessions Paper p.485), and even if the prisoner is not Smith the evidence of his guilt is overwhelming. He was identified by ten women whom he had defrauded quite positively. There was also the evidence of Mr. Gurrin as to the handwriting on the forged cheques and its identity with the prisoner's writing.' The Report comments that the minute 'assumes as conclusive evidence which was only conclusive because all evidence to the contrary was excluded by the ruling impugned.' A further minute written in July, 1898 and also reproduced in *The Times*, 1904e, states, 'The Common Serjeant [sic] has not the slightest doubt that Beck is the man who robbed the women in 1895; whether he is also the man who was convicted of a similar offence in 1877 is open to doubt, but this is really immaterial, as Beck is being punished only for the offence proved in 1896'.

^{xxxv} Not least, the 'overwhelming evidence of identity' (*The Times*, 1904e). Beck had been mistakenly identified by the female victims of 1877 and again by the victims of 1904 as being Thomas Smith. Even though certain physical features did not correspond with those of John Smith, this was to be disregarded by those in the judicial system. 'Had it come to this,' *The New York Times* (1904), demanded, 'that the police secured convictions at the expense of truth and Judges sentenced to save trouble?' (p.SM2).

^{xxxvi} As for note xxviii, sentence 2.

^{xxxvii} The words of Mr Mathews, the counsel for the prosecution against Thomas Smith in his trial of 1904, are partly reproduced in Irving (2008).

^{xxxviii} A comment made in the death notice for Adolf Beck. See also *The New York Times* (1904).

^{xxxix} See also, Irving (2008) p.32.

^{xi} *The New York Times* (1904) stated that it was through the 'individual efforts' of George Sims that an inquiry into the persecution of Adolf Beck was made and Simms was described as the 'Emile Zola of the hour' (p.SM2). Sims presented Beck's case in his column printed in the *Daily Mail* in an attempt to publicise his plight and secure justice for him. The *Daily Mail* article is reproduced in Maybrick (1904) p.160.

^{xli} Bragg, Melvyn (2009) The Dreyfus Affair. In: *In Our Time*. BBC Radio 4. 8 Oct., 21:30 hrs.

^{xlii} See also Kayser, 2005, p.23

^{xliii} In Emile Zola's open letter, *J'Accuse*, published on the 13 January, 1898 in the Socialist newspaper *L'Aurore* (see end note xlix), he wrote that Dreyfus 'cannot be found innocent without the whole General Staff being guilty'. The Minister of War, General Mercier, had, in the summer of 1894, been accused 'of having treasonably released a German spy' which threatened his ministerial career. To prevent his ruin, he was particularly eager to obtain a conviction of the writer of the *bordereau*: at least the conviction of someone that could be said to have written the *bordereau*. As Dreyfus was already unpopular amongst the General Staff, to a great extent because he was an Alsatian Jew, he was the perfect scapegoat. When it became apparent that Esterhazy was, in fact, the author of the *bordereau*, the General Staff began their attempt at covering up this fact. In 1906, *The Times* wrote, 'it is easy enough to see that [Dreyfus] was but a pawn in a tremendous game and that in the eyes of the players he counted for no more than a private soldier in some great military operation. Probably some personal animosity determined the choice of the individual, but if it had not been Dreyfus it would have been another' (*The Times*, 1906).

^{xliv} *The New York Times* (1899b) published an article detailing the previous day's proceedings of the second Court-Martial of Captain Dreyfus. In it, the writer comments that, 'The Dreyfusards [supporters of Dreyfus] refuse to regard [Bertillon] as anything but the prince of quacks. They cover his remarks with ridicule and protest that the admission of his fantastic theories as evidence before the court-martial is a disgrace to France' (p.2).

^{xlv} On being shown a letter written by Esterhazy, who was later proved to have been the writer of the *bordereau*, Bertillon exclaimed, 'Why, [...] it is the writing of the *bordereau*. Where did you get it?' When told that it had been written at a date after the *bordereau*, M. Bertillon exclaimed, 'For years past the Jews have been keeping some one hard at work to produce the writing of the *bordereau*, and they have perfectly succeeded; that is evident.' (*The New York Times*, 1899c, p.2). See also Derfler (2002) p.68 and Christenson (1991) p.110.

^{xlvi} *The New York Times* (1899) stated that it was only after Bertillon had been called in to the War Office to examine the writing of the *bordereau* that he became a handwriting 'expert for this special occasion'. Bertillon was, however, highly revered in France as a criminologist and invented a system of anthropometric measurements to aid criminal identification which was named Bertillonage. This system was later superseded by fingerprint identification (Hannavy, 2007, p.1143).

^{xlvii} *The New York Times* (1906) writes that Du Paty de Clam, charged with identifying the author of the *bordereau*, became certain that Dreyfus was the culprit. The paper writes that '[t]he resemblance in handwriting became an inspiration to him, then a conviction' (p.2). When Du Paty de Clam described his findings to Bertillon, who was described as 'an impressionable man,' the paper continues that '[t]he eloquence of Du Paty impressed him, and he declared that the writer of the *bordereau* and the writer of the submitted letters were one and the same man' (p.2).

^{xlviii} *The New York Times* (1899a) provides a detailed account of Bertillon's 'unintelligible exposition of his theories':

A remarkable feature of M. Bertillon's deposition was the heat and excitement he put into what was expected to be a calm, dispassionate exposition of his theories. He thundered, shouted, and waved his arms as though engaged in some terrible dispute. Once he literally shrieked, and numbers of the usual audience, who had been unable to follow him and were taking the air in the courtyard, rushed back into the hall, breathlessly inquiring what had happened and imagining that he was fulminating some dreadful denunciation of the accused. Their excitement was turned into hilarity when they found that he was merely impressing upon the Judges the significance of the exact space, measured in centimetres, between two words in the *Bordereau* (p.1).

^{xlix} A translation of the text of *J'Accuse* is available online at: <http://www9.georgetown.edu/faculty/guieu/j/others/iaccuse/jaccuse.htm>

ⁱ See *The New York Times* (1899b). Esterhazy did, however, retract his confession later (Anstey and Silverlight, 1991, p.47).

ⁱⁱ 'Le Corbeau, literally meaning crow or raven, is a French slang word for a writer of poison-pen letters. The word has become synonymous in France with an 'auteur anonyme' since Henri-Georges Clouzot's film 'Le Corbeau' of 1943, in which an anonymous letter writer using the pseudonym 'Le Corbeau' sends a series of letters to terrorize a small town (Lloyd, 2003, p.198; Gassiot, and Moron, 2002, p.311). The term was used recently in the 'Clearstream Affair', in which an anonymous letter was sent to French prosecutors alerting them to apparent corruption among French politicians (Bremner, 2006). 'The Crow' pseudonym was also used to describe the anonymous letter writer in the infamous French murder case, the 'Villemin Affair'. In 1984, a four-year-old boy, Gregory Villemin, was murdered after a series of threatening anonymous letters had been sent to his family. The Villemin family subsequently turned in on itself and against each other. The child's father, Jean-Marie Villemin, shot dead Bernard Larouche, his cousin, believing him to have been the murderer of his son. The mother of 'Petit Gregory', as the little boy became known to the French public (Nundy, 1993), has also been accused of his murder, but her guilt was never proved and she was officially cleared in 1993. To date, the murder remains unsolved. (Davis, 2009; Delmas-Marty and Spencer, 2002, p.690).

^{lii} Plinius Caecilius Secundus (c.62 AD - c.112 AD).

^{liii} The tenth book of Pliny's collection of letters. These letters were written from c.110/111 to 112 (Firth, 1892, p.7; Trapp, 2003, p.14). The ten-volume *Epistulae* contain 270 personal letters (Trapp, p.14) and provide us with, what Firth (1892) has described as a 'fascinating [and] absolutely unique' insight into Roman social and political life (p.5). These letters, Westcott (1899) wrote, 'have ensured the author's immortality in the popular mind' (p.xii).

^{liv} This translation is taken from Cruttwell (1878) p.440.

^{lv} *Ibid*, p.441.

^{lvi} The Prime Minister, Augustus Henry Fitzroy, third Duke of Grafton (1735-1811), and his government were often the targets of Junius's invective and political satire; Sir N.W. Wraxall (1845) comments that:

Junius may indeed justly be reckoned among the leading causes which drove the Duke of Grafton from the helm of affairs. I have been assured by persons of honour and veracity, who were in the habits of continually seeing Mr. Bradshaw, then secretary of the treasury, and of knowing his private sentiments, that he made no secret to them, of the agony into which the Duke of Grafton was thrown by these productions. Such was their effect and operation on his mind, as sometimes utterly to incapacitate him during whole days, for the ministerial duties of his office' (p.155).

^{lvii} King George III. Born 1738 (ruled 1760 – 1820).

^{lviii} See for example **The Letters of Junius**, Volume 1, (1811), letter dated December 19th, 1769. In this letter written to King George III, Junius concludes:

These sentiments, sir, and the style they are conveyed in, may be offensive, perhaps because they are new to you. Accustomed to the language of courtiers, you measure their affections by the vehemence of their expressions; and when they only praise you indifferently, you admire their sincerity [...] The people of England are loyal to the house of Hanover; not from a vain preference of one family to another, but from a conviction, that the establishment of that family was necessary to the support of their civil and religious liberties. This, sir, is a principle of allegiance equally solid and rational; fit for Englishmen to adopt, and well worthy of your majesty's encouragement. We cannot long be deluded by nominal distinctions. The name of Stuart, of itself, is only contemptible; armed with the sovereign authority, their principles are formidable. The prince who imitates their conduct, should be warned by their example; and, while he plumes himself upon the security of his title to the crown should remember, that, as it was acquired by one revolution, it may be lost by another' (p.194).

(Note lviii cont'd..) See also Sir N.W. Wraxall, Bart., (1845): 'Nor did [Junius's] pen, after exposing the want of spirit and energy in the government, respect even the majesty of the throne' (p.154).

^{lix} An article from *The Indian Observer*, reproduced in **The Critical Review** of September, 1801, discussed the problem of the author of the Junius letters. The article notes that the Junian handwriting 'was various, sometimes evidently disguised, sometimes the fine Italian of a lady of that period' (vol. XXXIII, Article IX, p.192).

^{lx} Osborn (1946) was of the opinion that Sir Philip Francis did not possess the necessary literary or linguistic skill that the author of the Junius letters displayed. Osborn considered John Horne Tooke (1736-1812) to be a more likely candidate since Tooke 'possessed every qualification necessary in the author of the famous letters. One of these 'qualifications' was the fact that he was one of the victims and another was that he had the ability to write them. The investigation of the authorship of anonymous letters, handwriting and documents, now quite common, had not been developed in England in 1769-1772 and it was not known that when anonymous letters are sent to several individuals one of the supposed victims may be the actual writer in one out of every four or five cases ' (p.128).

^{lxi} See for example, Noorani, (2005).

^{lxii} See for example, Bell, (2009); Lister, (2008); Scott, (2007); Cross, (2009); Braid, (1999); *Telegraph* (2009); Kraft, (1993).

^{lxiii} Get-Revenge-On-Your-Ex.com is a rather unpleasant website created by Nick James after he discovered that his wife had been having an affair. The website states, '[i]t has to be said that Nick James was truly a Master of Revenge. Now, you too can discover his secrets and use his tactics to get revenge anonymously [and] effectively [...] on your ex.' [Online]. Available at: <http://www.getrevengeonyourex.com/v2/index.php> (Accessed: 2 March, 2010).

^{lxiv} On the 26th October, 1605, an anonymous letter was sent to Lord Monteagle and is said to have been the manner in which the government were first alerted to the Gunpowder Plot of 1605 (Cassell, J., 1859). The writer vehemently warned Monteagle to stay away from Parliament and ‘retyere to youre self into youre contri’ as ‘they shall receive a terrible blowe this parliament, and yet they shall not seie who hurts them’ (See Cassell, John, (1859) **Illustrated History of England**, Vol. III From the Accession of James I. to the Revolution of 1688, London: Cassell, Petter and Galpin, pp.25-26). The identity of author of the anonymous letter was never established, but it is thought that Lord Monteagle’s brother-in-law, Francis Tresham, one of conspirators, was the writer. (Harland (ed.) 1859, p.251).

^{lxv} For an example of a benevolent anonymous letter see End Note li above, ‘The Clearstream Affair’.

^{lxvi} See for example the JonBenet Ramsey ransom note which is reproduced in *The Times* (2006). See also *State v. Hauptmann*, 115 N.J.L. 412, 180 A. (1935).

^{lxvii} Eight document examiners were involved in the Hauptmann case: Albert S. Osborn, Albert D. Osborn, Elbridge W. Stein, John F. Tyrrell, Herbert J. Walter, Harry E. Cassidy, Wilmer Souder and Clark Sellers (Levinson, 2001, p.5). Nickell, and Fischer, (1999) also mention Charles Appel as a key handwriting examiner in the case. They write that ‘Appel’s handwriting comparison [as used in the Lindbergh trial] was so strong that it is still used in the training of document examiners’ (p.168).

^{lxviii} Graffiti also, of course, includes drawings, but for the purposes of forensic document examination, only writing is considered here.

^{lxix} New York Police Department (1994).

^{lxx} See for example Osborn (1922) p.289; (1929) p.407; (1946c) p.140; Brewster (1932) pp.112-3; Conway (1955) p.609; Webb (1978) pp.149-154; Hilton (1982) pp.168-171; Robertson (1991) pp.244-246; Slyter (1995) p.56-57; Ellen (1997) p.32; Hayes (2006) pp.164-166.

^{lxxi} See also Keckler (1997) p.154.

^{lxxii} Before Herkt, there had only been Michel (1978) who had dealt solely with signature disguise. Alford studied the disguise of both signatures and extended text.

^{lxxiii} Keckler's study provides interesting information as regards the subject of disguise, but in light of the high degree of subjectivity that appears to have been introduced into the selection process of the exemplars and into the process used for determining the convicts' disguise techniques, the findings from this study must necessarily be regarded as preliminary. In contrast to a controlled experiment, where the subjects are specifically requested to disguise their writing, Keckler states only that a 'careful interpretation and judgement' was used to examine and compare the exemplars to determine which particular handwriting constituted each convict's natural handwriting and which constituted their disguised writing (p.154). It cannot, therefore, be known for certain that any particular writing in this study was, without doubt, disguised; we know only that the researcher has studied them and has concluded that they were disguised. Furthermore, the information that was used to determine the natural writing of each subject for comparison with what was deemed to be the disguised writing was taken only from the exemplars and no examples of the subjects' day to day handwriting was requested or obtained.

^{lxxiv} See also Brewster (1932) p.112; Robertson (1991) p.244, Dines (1998) p.99 and Harrison, 1966, p.135.

^{lxxv} Alford 94%; Downey 94%; Kropinak 71%; Konstantinidis 69%; Keckler 53% Harris 52%.

^{lxxvi} 11 of Wendt's subjects (9% of the total sample) used a change of slant as a method of disguising their handwriting.

^{lxxvii} Although Alford mentions that '[t]he findings regarding terminal strokes generally parallel[...] those of approach strokes' (p.483) he is here writing of approach strokes only.

^{lxxviii} Brewster (1932) and Conway (1955), for example, define *handprinting* as being non-cursive printed capitals (Brewster, p.114; Conway, p.606); but this definition is the same as that which comes under Hayes (2006) and Keown's (1994) category of *Block Capitals*. Furthermore, *manuscript writing*, is defined by Hayes as being printing which combines upper and lower-case letters, but is categorized by Conway as *lower-case printing*, which, he tacitly implies, is printing that is confined to the use of lower-case letters only. Additionally, *script* is referred to by Conway as the 'conventional style of modern cursive handwriting' (p.606), while Harrison (1966) defines it as the disconnected script that is taught to children before they are taught the more speedier cursive, or connected, script (pp.362-363).

^{lxxix} 'Amerithrax' was the code-name given to the case by the Federal Bureau of Investigation (FBI). The anthrax letters killed five American citizens and injured seventeen and is said to be 'the largest and most complex [criminal investigation] in the history of [U.S.] law enforcement' (FBI, 2010). The culprit was never caught, although a suspect, Dr. Bruce Ivins, was named in August, 2008. However, Dr. Ivins subsequently committed suicide before any charges could be brought against him. (FBI, 2010).

^{lxxx} See the FBI Amerithrax Press Briefing, 9 November, 2001 which details the anonymous letters (FBI, 2001).

^{lxxxii} Although Keckler does not here define his use of the word 'printing', it becomes clear in his conclusion that he is, in fact, referring to block lettering (Keckler, 1997, p.157).

^{lxxxiii} See note lxxiii

^{lxxxiv} This study is frustrating in as much as Herkt does not provide a definition for his category of 'printing'. He merely states that two of his 'subjects printed their initials while the remaining five included printed forms in the body of the signature' (p.261). Although it is not explicitly stated, we can, perhaps, assume that the printed initials were made in block capitals since these are typically used at the beginning of names in a signature. Since Herkt makes no distinction between his description of the printing of initials and the printing of letters in the body of some signatures, I have assumed that block letters were also employed here.

^{lxxxv} Arrangement can, of course, also include the spacing between letters and words; but since this feature has received particular attention in the anecdotal and empirical literature, it has here been treated separately under the heading *Lateral Spacing Alteration* at 1.4.12.1.

^{lxxxvi} Downey (1917) does not explicitly define her meaning of the word 'alignment' in her article, but from the sub-categories she uses in Table I, (*Straightened, More Serpentine, Rising, Falling*), it appears that she is here referring to baseline alignment (p.371).

^{lxxxvii} 17% is a corrected figure. There are often problems with Herkt's work in that the figures and percentages that he reports are often inconsistent or incorrect. In some instances the percentages have been rounded up to the nearest whole number, at other times they have not. For consistency, therefore, any inaccurate percentages have been corrected where necessary and this is noted where applicable.

^{lxxxviii} Harris found less than 10% of his subjects, Wendt 2%, Keckler 0.5% and Alford 2% respectively.

^{lxxxix} The distinct symbol Å (å) is used in Danish, Norwegian, Swedish and Walloon to represent an '[o]-type vowel' (Wells, 2001).

^{xc} An exception to this is Hayes (2006). His is the lone voice that comments that the use of the non-dominant hand is 'a somewhat uncommon disguise technique' (p.165).

^{xci} It is interesting to note two of the most famous mirror-writers: Leonardo Da vinci and Lewis Carroll. Da Vinci wrote his notebooks in an enigmatic mirror-writing, while Lewis Carroll wrote letters occasionally in this way to amuse the children to whom he was writing. Carroll also incorporated mirror-writing in his book, *Through the Looking Glass*, in the poem *Jabberwocky*. (See McManus, 2004, p.318; Wright, 2007, p.131).

^{xcii} Of the 62.5% of subjects that altered their pen pressure in Downey's (1917) study, 80% of these increased pressure. Herkt (1986) and Konstantinidis (1987) report a lower frequency of use (8% and 10% respectively), but 100% of those who altered pressure in Herkt's study and 67% of those who did so in Konstantinidis's study were also found to have increased it. Leung et al. (1988) found that 30% of their subjects altered pen pressure and although they state that 'there were approximately equal proportions of volunteers who drastically increased or decreased the pen pressure' (p.160), it was the case that there was a slight tendency for the pen pressure to be increased.

^{xciii} A serif is defined as a slight projection that completes a stroke of a letter.

^{xciv} Harris does not define what is meant by his term 'modern commercial system', however, it is assumed that he is here referring to the method of cursive writing that was popular in North America from the late nineteenth-century into the middle of the twentieth-century. The Palmer method of writing was developed by Austin Norman Palmer who intended it to be a more practical form of penmanship that would be particularly suited to business. It was a plainer and more simplified form of writing than the elaborate and highly ornate Spencerian form it came to replace (Plakins Thornton, 1996, p.67).

^{xcv} The term 'English system of writing' is used here to incorporate both Standard British English and Standard American English. They are viewed as two variants of the same writing system since both forms generally use the same set of symbols and follow the same conventions to represent the English language, albeit with occasional variations.

^{xcvi} A total of ninety-eight respondents took part in the study conducted by Konstantinidis. However, Konstantinidis states that samples from six respondents were not included in the results because of a failure to properly follow instructions (p.386). Nevertheless, Konstantinidis often fails to take this fact into account and frequently provides data based on a total number of ninety-eight individuals. The figure given here of 78% (72 subjects) takes these six subjects into account and is, therefore, based on a total figure of ninety-two respondents.

CHAPTER 2 – IDENTIFYING THE CHARACTERISTICS

^{xcvii} English translations of Locard's principle of exchange are taken from Horswell and Fowler (2004).

^{xcviii} See also Blackburn and Caddell, 1909, p.51.

^{xcix} Disguised handwriting can, of course, be made with any writing instrument, including a pencil, but modern forensic handwriting casework generally concerns writing made in ink, usually with a ballpoint pen, and that is what is examined here.

^c In the case of Albinger's Will, the court described the qualities of a genuine signature as having 'a dash and a swing about the stroke which evidences a quick and confident penman.' This quote is also cited in Baker, 1955, p.258.

^{ci} Regent (1979) has also reported that a change of pressure occurs when a handwriting slant is altered. It is clear from his report that Regent believes that these pressure changes are the result of deliberate intent. Regent provides no evidence, however, to support this claim, which seems unlikely since his study specifically sought to identify the effects, or unintentional by-products, that would occur when a change of slant was the only deliberate alteration made by the writer. Regent comments that his findings on pressure tend to negate other writers' assertions that pressure cannot easily be altered intentionally (p.218): on the contrary, his findings would seem to endorse their claims.

^{cii} This figure has been corrected: Herkt reports that 15 subjects out of a total of 72 introduced breaks into their disguised writing and gives this as a percentage of 20%. More precisely, this figure should be 20.8%, and since Herkt frequently rounds up the figures given in his report, this percentage has here been similarly treated for the purposes of accuracy.

CHAPTER 3 – TRACED FORGERY

^{ciii} The presentation given by Alford and Bertocchi in 1974 at the meeting of the American Academy of Forensic Sciences is cited in Huber and Headrick (1999) p.281.

^{civ} See also section 1.4.13

^{cv} See section 2.2.2.1

^{cvi} See also section 1.4.7

^{cvii} Although *The Wrong Box* was first published in 1889, this quote is taken from an edition published in 1913 by Longmans, Green and Co. See Bibliography for full citation.

^{cviii} See, for example, Warwick (2003). This reference book provides a model for helping young children to acquire and develop handwriting; it advocates the technique of tracing throughout.

^{cix} Both Osborn (1929) p.341 and Baker (1955) p.255 quote from the opinion given in *Kemp v. Mackrill*.

^{cx} See for example, Osborn (1929) p.207; Rhodes (1934) p.48; Baker (1955) p.266; Bradford and Bradford (1992) pp.7-9; Koppenhaver (2007) p.49.

^{cxⁱ} See also Osborn (1929), in which he refers to this case as ‘one of the most famous ever tried’ (p.348).

^{cxⁱⁱ} Richard Mawrey Q.C. was appointed to sit as the Commissioner for the trial of the Election Petition for the Bordesley Green and Aston Wards of Birmingham City Council, which arose from an election held on 10 June, 2004. He delivered a detailed Judgement in the Petition on April 5, 2005.

^{cxⁱⁱⁱ} Since most handwriting casework consists of the alleged traced forgery of signatures that is what will be examined here. The tracing of extended text will not, therefore, be explicitly or separately described, but it is to be expected that any observations that can be made about traced signature forgery will apply equally to the tracing of extended text.

CHAPTER 4 – THE CHARACTERISTICS OF TRACED FORGERY

^{cxiv} See, for example, Gupta (1979), who states that '[t]raced forgeries are easily detected by careful observation and the inherent signs of imitation and tracing are present in such a gross manner that they rarely pass unnoticed by an expert' (p.20).

^{cxv} See also Dines, 1998, p.270.

^{cxvi} This is a corrected figure. Herkt mistakenly notes that 106 samples out of 144 represent 37%.

^{cxvii} Quirke makes no specific reference to the type of writing instrument/s that will produce the ragged edge stroke he describes. But given that he was writing in the early part of the twentieth century, it is assumed here that he refers to ink or dip pens that would have commonly been used at that time.

^{cxviii} Modern pencil leads tend to comprise of bonded graphite mixed with china clay to form ceramic rods (Morris, 2000, p.120). However, pencil 'leads' can also be charcoal or plastic based, although these are unlikely to be used for tracing purposes as they do not tend to be as readily available as the ubiquitous commercial pencil; moreover, in the case of charcoal instruments, these do not easily produce fine detail (Hodges and Rawlins, 2003, p.26).

^{cxix} The ESDA machine has proved to be an important forensic tool that can reveal shallow and otherwise invisible, indented writings and other impressions without damaging or marking the paper on which they occur. The questioned document is laid on a porous metal plate with a protective sheet of cellophane placed on top. By means of a vacuum drawn through the plate, both the document and the cellophane sheet are forced tightly together. An electrostatic charge is then passed over the cellophane covered document by means of an electrically charged wand, creating a higher static charge in the impressed areas of the document than upon its surface. When charge-sensitive toner (dry powdered ink) is subsequently applied over the plastic surface of the document, the charged particles are attracted to, and collect in, any indented impressions, rendering them visible (Girard, 2006, p.167; Jackson and Jackson, 2004, p.234; Kaye, 1995, p.67).

^{cxx} Some state that the origins of the axiom, 'Nature never repeats itself' can be attributed to the Belgian statistician and astronomer, Adolph Quetelet, 1796-1874 (Saks, 1994, p.430), while others suggest that it can be traced back to the German philosopher and mathematician Gottfried Wilhelm Leibniz, 1646-1716 (Cummins and Midlo, 1976, p.150). However, in a letter to the editor of the Journal of Forensic Science in April, 1986, Thornton (1986) suggests that the doctrine of uniqueness on the part of all tangible objects generally takes one of two forms:

The first is the metaphysical argument advanced by a number of classical philosophers (Heraclitus, Parmenides, Zeno and Plato), and further developed in the 17th century by Leibniz. This argument states that an object can be identical only to itself. The second form of the uniqueness argument is the one invoked for forensic science purposes. [...] This form of argument is frequently voiced as 'Nature never repeats itself' and is attributed to the Belgian statistician Quetelet' (p.399).

^{cxxi} See, for example, Mayo, 1857, p.201; Boulding, 2002, p.2; Huntsman, 2005, p.99.

^{cxxii} See also Osborn, 1929, p.338

^{cxxiii} See also Blackburn and Caddell (1909) p.65; Baker (1955) p.257.

^{cxxiv} See also Osborn, 1929, p.139; Hilton, 1939, p.573

^{cxxv} See Keckler p.154 who used an age range of 20 - 54

^{cxxvi} The overall study was limited to sixty individuals as this number of participants created 420 disguised, traced and natural handwriting samples, which involved the input of just over 467,460 separate data points into the database. Since the analysis of handwriting is necessarily a lengthy process, this was deemed a practicable amount that could reasonably be examined by a single researcher in the time constraints involved.

^{cxxvii} Mangione (1995) has categorized postal response rates as follows: Above 85% - excellent; 70-80% - very good; 60-70% - acceptable; 50-60% - barely acceptable; Below 50% - not scientifically acceptable (pp.60-61).

^{cxxviii} The completion rate is the number of people who finished the survey divided by the number who started it (Poynter, 2010, p.82).

^{cxxix} Four participants stated that they had produced one of their two sample signatures freehand. These signatures had therefore to be discounted from the study so that only 56 tracings were examined instead of an expected 60.

^{cxxxi} Quoted also in Lafone (2005) p.67.

^{cxixi} Reproduced from Lafone (2005) p.108.

^{cxixii} See section 1.4 for further clarification of the elements that comprise the appearance of handwriting.

^{cxixiii} This figure includes the samples of three participants who did not state explicitly in their questionnaire that an alteration of slant was a disguise method that they had employed. However, since a positive change to the normal slope of their writing was observed at the outset of their disguises, and an attempt was apparently made by these writers to maintain the new slant, these changes were considered non-accidental and deemed conscious disguise methods. This was confirmed by the participants in follow-up communications subsequent to the survey.

^{cxixiv} Copy book writing is not included here under the definition of simplification, even though this may be considered a plainer, simpler form of writing. Copy book writing will instead be treated under the separate heading of Handprinting in Section 6.1.7.

^{cxixv} See section 2.2.3.5

^{cxixvi} See section 1.4.6

^{cxixvii} Also cited in Nickell (1996) p.71.

CHAPTER 6: DATA ANALYSIS

^{cxviii} See, for example, Hayes, 2006; Morris, 2000; Huber and Headrick, 1999; Dines 1998; Ellen 1997; Nickell, 1996; Keown, 1994; Alford 1970; Harrison, 1962 and Harris, 1953.

^{cxvix} See also section 6.2.5.7

^{cxl} One third of the signature samples contained no cross-bar strokes at all.

^{cxli} Refer also to section 6.2.6.

^{cxlii} Deviant writing samples taken from Lafone (2005) pp.A30-A120.

^{cxliii} See section 6.2.1.14

^{cxliv} See section 6.4.1.4

^{cxlv} See also section 2.2.1.2.1

^{cxlvi} See Section 2.1

^{cxlvii} See section 6.2.1.6

^{cxlviii} See Lafone (2005) where it was reported that 17% of all the freehand-simulated signatures examined displayed marks of retouching and overwriting (p.162).

CHAPTER 7: SUMMARY AND CONCLUSION

^{cxlix} According to findings reported in section 6.2.3.3 above and in Lafone (2005), p.119, 50% of disguised writing and 55% of freehand simulations displayed marks of hesitation.

^{cl} See section 6.2.3.6.

^{cli} See section 6.2.3.6.

^{clii} See section 4.2.1.7.

^{cliii} See section 4.2.9.

^{cliv} See also Section 4.2.11)

^{clv} See sections 6.4.1.4 and 6.4.6.

^{clvi} The purpose of the North American Federal Rules of Evidence have been ‘construed so as to administer every proceeding fairly, eliminate unjustifiable expense and delay, and promote the development of evidence law, to the end of ascertaining the truth and securing a just determination’ (United States. Federal Rules of Evidence 102).

^{clvii} Where results are the same for two or more characteristics, these are placed in alphabetical order.

^{clviii} In summing up his opinion of the admissibility of handwriting evidence in *US v. Crisp*, Judge King wrote, ‘To the extent that a given handwriting analysis is flawed or flimsy, an able defence lawyer will bring that fact to the jury’s attention, both through skilful cross-examination and by presenting expert testimony of his own. But in light of Crisp’s failure to offer us any reason today to doubt the reliability of handwriting analysis evidence in general, we must decline to deny our courts and juries such insights as it can offer.’ (*United States v. Crisp: Appeal*, 2003, p.15).

^{clix} Where results are the same for two or more characteristics, these are placed in alphabetical order.

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APPENDIX I

SAMPLE SIZE DISTRIBUTION (GENDER/ETHNICITY/AGE/CRIMINAL GROUPING) [Figures calculated using data from the Ministry of Justice (2010) Sentencing Statistics: England Wales 2008]

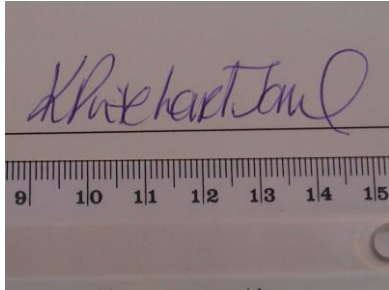
Offenders Sentenced for Forgery and Fraud by Sex and Age Group	
Adult Males - Fraud and Forgery	
Male Young Offenders (18-20)	1,087
Total Males:	13,622
Adult Females - Fraud and Forgery	5,746
Female Young Offenders (18-20)	314
Total Females:	6,060
Total Male/Female Offenders:	19,682

Sample Size and Distribution		
Distribution of Males and Females and of Age Group	Distribution (based on a sample size of 60)	
69% Men	Male	38
31% Women	Female	18
Of these we need:	Male (18-20)	3
8% Young Males (18-20)	Female (18-20)	1
5% Young Females (18-20)	Total Sample:	60

Ethnicity			
Using Ministry of Justice Statistics & categories from their annual report, Race & the Criminal Justice System 2007/8, a police force area was picked at random and the % breakdowns for ethnicity in that area was used for this study.			
Bedfordshire Police Area.			
Ethnic Distribution		Distribution (based on a sample size of 60)	
45%	White	White	27
28%	Black	Black	17
22%	Asian	Asian	13
5%	Other	Other	3

APPENDIX II MEASUREMENT OF THE MODEL SIGNATURE

Model Signature in the name of K. Pritchard Jones



Overall Horizontal Size:

To appraise horizontal size, a measurement was taken between carefully defined features at the extremities of the signature. A horizontal line was drawn from the base or lowest point of the stroke extending furthest to the left hand side of the signature to the base of the stroke extending furthest to the right hand side of the signature.

Mid-Zone Height

The following linear letters were measured because they were formed clearly in the model signature and were recognizable as individual letters. This clarity of form allowed more precise measurements to be taken. 'c', 'a', 'o', 'n'

To obtain the vertical dimension of each letter, a perpendicular line was drawn from its highest vertical point, or apex, to its lowest vertical point, or base. This procedure was the same for both vertical and slanted letters (see Figures A1 & A2).

APPENDIX II MEASUREMENT OF THE MODEL SIGNATURE

ii) Measuring Inter-Word and Intra-Word Spacing

A horizontal line was drawn between the consecutive letters in the following ways:

Where letters possessed staffs (e.g. K-P, and P-r) a horizontal line was drawn between their staffs at the baseline. Where letters were curved, hooked, or were in some way constructed differently at their base, a horizontal line was drawn between the corresponding mid points on each letter; mid point is defined as being mid way between the highest and lowest points of the stroke. It was found to be unreliable to measure between such letters at the baseline since it was difficult to judge, with any consistency, where the points of measurement should be made.

When measuring the space between a letter possessing a vertical staff and a curved letter or vice versa, for example, t-c, c-h, and J-o, a horizontal line was drawn between the mid point on the vertical staff and the mid point on the back of the curved letter.

iii) Baseline Alignment

A vertical line was drawn up or down from the base of as many letters as practicable to the baseline. It was sometimes appropriate to measure from several points within one letter, for example from the base of the two legs of a

APPENDIX II MEASUREMENT OF THE MODEL SIGNATURE

capital A. A mean calculation was made of the resulting vertical dimensions to give the signature's baseline alignment. A plus (+) number indicates that the signature was above the baseline; a minus (-) number indicates that the signature was below the baseline. A zero (0) indicates that the signature rested on the baseline. Where a signature undulated above and below the baseline, it was necessary to provide both a plus and minus number.

Relative Height

i) Measuring upper case letters:

The following letters were measured: K, P and J

A perpendicular line was drawn from the top or apex of each capital letter to its base, which did not necessarily coincide with the base line of the writing.

Measuring the heights of the upper projections of supralinear letters:

A letter's upper projection is defined as being any stroke extending above the 'x' height; The following letters were measured: t, h, and d

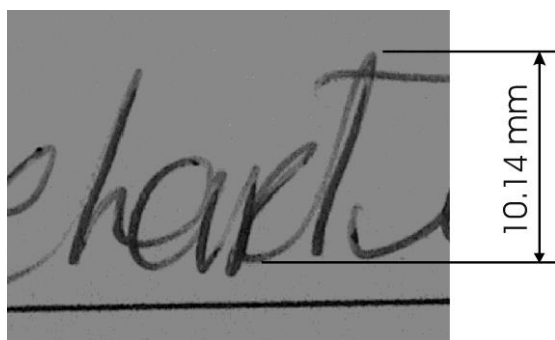


Figure A3 – Upper Projection of Supralinear Letter

APPENDIX II MEASUREMENT OF THE MODEL SIGNATURE

A perpendicular line was drawn from the top of the stroke forming each letter's upper projection to the base, or lowest part, of the stroke, which did not necessarily coincide with the base line of the writing.

ii) **Measurement of the component parts of a letter:**

For a definition of the component parts please refer to the Glossary of Terms.

The component parts of the following letters were measured: K, P, h, d, t

'K' - Component parts: 1) staff, 2) lower leg extending downwards from staff

1) A perpendicular line was drawn from the top of the staff to its lowest point to obtain its height.

2) A vertical line was drawn from the top of the stroke, (i.e. from its intersection with the staff) to its lowest point (i.e. at the end of the downward stroke, before it changes direction upwards to create the connector stroke to the letter P).

'P' Component parts include: 1) staff, 2) bowl

1) A vertical line was drawn from the top of the staff to its lowest point to obtain its height.

APPENDIX II

MEASUREMENT OF THE MODEL SIGNATURE

2) A vertical line was drawn from the top of the bowl to its intersection with the staff to obtain its height.

‘h’ Component parts include: 1) staff, 2) arch

1) A vertical line was drawn from the top of the staff to its lowest point to obtain its height.

2) A vertical line was drawn from the highest point of the arch to the baseline of the letter.

‘d’ Component parts include: 1) staff, 2) bowl

1) A vertical line was drawn from the top of the staff to its lowest point to obtain its height.

2) A vertical line was drawn from the highest point of the bowl to its lowest point, or base.

‘t’ Component parts include: 1) staff, 2) horizontal cross stroke

1) A vertical line was drawn from the top of the staff to its lowest point to obtain its height.

APPENDIX II MEASUREMENT OF THE MODEL SIGNATURE

- 2) A vertical measurement was taken from the lowest point of the staff to its intersection with the crossbar to determine the height of the crossbar.

Ratio of Letter Height to Width

The following characters were measured; K, P, h, a, d, J, o, n. and final loop.

The ratio of each character was found by dividing its height by its width. A vertical line, drawn from the top, or highest point, of each character to its lowest point, or base, determined the height. The base of the loop was defined as being the point at which its ascending and descending strokes intersected.

The width of each character was found by drawing a horizontal line from the point furthest to the left hand side of each letter's staff (or where there was no staff, the furthest point left of the letter's axis) to the point furthest to the right hand side. The measurement included the body of the letter only and excluded any connecting strokes. It is rare to find a person's handwriting following consistently the copybook norm, and it was often difficult to judge where the body of a letter ended and where a connector stroke began; a certain amount of subjectivity, and so imprecision, was necessarily involved in making these decisions. Generally speaking, however, the width or body of a letter typically ended at the lowest point of the final stroke, at the point where the stroke changed direction to create a connector. In the absence of a change of direction in the stroke, the letter's body was judged in relation to other strokes that formed the letter. For example; h, a, d, o, n (see figures A4 & A5).

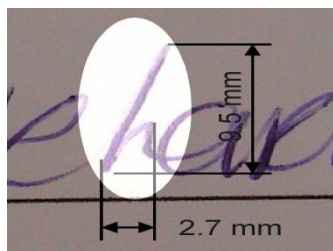


Figure A4 – Measuring the Height and Width of a Letter

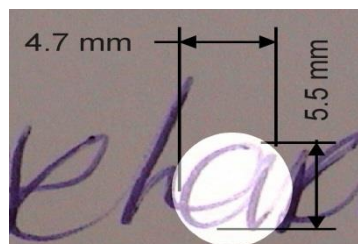


Figure A5 – Measuring the Height and Width of a Letter

It should also be noted that the height of each letter was not measured at the angle at which the letter was written as some examiners propose,¹ since such a method would depend upon the absolute accuracy of the angle found (see figure A6).

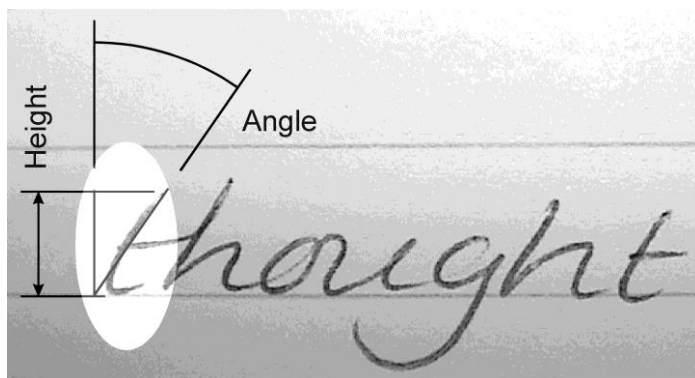


Figure A6 – Measuring a Forward Leaning Letter

¹ Schroeder (1974) measures the height of a letter from the foot to the top at the angle at which the letter is written.

APPENDIX II MEASUREMENT OF THE MODEL SIGNATURE

Internal Size of Loops or Ovals

The loops and ovals found in the following characters were measured: K, P, C and final loop.

Each oval was measured by drawing a line through its furthest two points to form an axis. The axis line was then measured inside the oval using the Slanted Dimension Tool to obtain its internal size (see Figure A7).

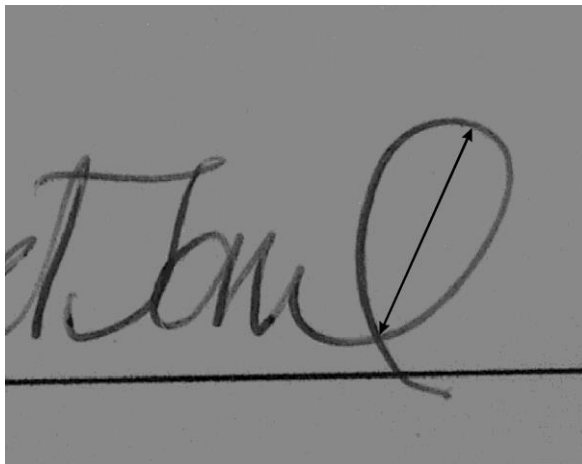


Figure A7 – Measuring the Internal Size of a Loop

APPENDIX III

Date



FORENSIC HANDWRITING SURVEY

Thank you so much for agreeing to take part in this research to catalogue the characteristics of handwritten disguise. It is hoped that this research will significantly improve the value of the evidence given by forensic experts in court.

The enclosed information pack includes various forms for you to fill out so that samples of your normal and disguised handwriting can be collected. Your pack contains the following:

- General Questionnaire:** A brief, entirely confidential form for collecting information about you
- Forms 1a & Form 1b:** For collecting samples of your normal, day to day handwriting
- Form 2:** For collecting samples of your disguised handwriting
- Disguised Handwriting Questionnaire:** To collect your assessment of the disguised writing you've produced
- Ball Point Pen:** For you to use during the experiment
- Pre-paid Envelope:** For returning the survey

It is crucial that the survey is conducted in a specific way and so instructions are included on all the forms which explain exactly how they should be filled out. Please take as long or as short a time as you like to complete these tasks, and use whatever method/s you think best to achieve your disguised forgeries.

Once you have completed the questionnaires and forms, please place them in the pre-paid, pre-addressed envelope provided and send them back to me as soon as you can, or at the very latest by **Date**.

If you have any queries before or during this exercise, please contact me on the phone number or e-mail address at the top of this letter.

With many thanks again for your invaluable assistance.

Kate Lafone B.A. (Hons), M.Phil.

APPENDIX IV

Date



FORENSIC HANDWRITING SURVEY

Thank you so much for agreeing to take part in this research to catalogue the characteristics of traced forgery. It is hoped that this research will significantly improve the value of the evidence given by forensic experts in court.

The enclosed information pack includes various forms for you to fill out so that samples of your normal and traced handwriting can be collected. Your pack contains the following:

- General Questionnaire:** A brief, entirely confidential form for collecting information about you
- Forms 1a & Form 1b:** For collecting samples of your normal, day to day handwriting
- Form 2:** For collecting samples of your traced handwriting
- Traced Handwriting Questionnaire:** To collect your assessment of the traced writing you've produced
- Ball Point Pen:** For you to use during the experiment
- Pre-paid Envelope:** For returning the survey

It is crucial that the survey is conducted in a specific way and so instructions are included on all the forms which explain exactly how they should be filled out. Please take as long or as short a time as you like to complete these tasks, and use whatever method/s you think best to achieve your tracings.

Once you have completed the questionnaires and forms, please place them in the pre-paid, pre-addressed envelope provided and send them back to me as soon as you can, or at the very latest by **Date**.

If you have any queries before or during this exercise, please contact me on the phone number or e-mail address at the top of this letter.

With many thanks again for your invaluable assistance.

Kate Lafone B.A. (Hons), M.Phil.

APPENDIX V

Form 2: DISGUISED HANDWRITING SAMPLES

Objective: To alter your handwriting in such a way that it cannot be identified as yours.

Procedure: Disguise your handwriting in ALL sections of this form, using any method/s you wish.

NAME:.....

SIGNATURE:.....

DATE:

[DD/MM/YY]

**Please copy the address
Below into Box E.**

BOX E

Mr & Mrs W.E. James,
c/o Gold Medal Hospital,
X-Ray Department,
Lincoln Road,
Postal Zone 'B'
New York City,
N.Y., U.S.A.

Please copy the passage below into Box F.

Our London business is good but Vienna and Berlin are quiet. Mr. D. Lloyd has gone to Switzerland, and I hope for good news. He will be there for a week at 1396 Zermot St. and then goes to Turin and Rome and will join Col. Parry and arrive at Athens, Greece Nov. 27 or Dec 2. Letters there should be addressed: King James Blvd 3510. We expect Chas E Fuller on Tuesday. Dr. L. McQuaid and Robt. Unger, Esq. left on the 'Y.X. Express' tonight & paid £12.84 for tickets.

BOX F

APPENDIX VI

Form 2: TRACED HANDWRITING SAMPLES

Objective: To produce two traced forgeries as accurately as possible so that someone could mistake your tracings for the real signature.

Procedure: Trace the model signature, which can be found on page 7, onto the dotted signature line below. Please then trace it again into the signature box. Use whatever method/s of tracing you prefer and take as much or as little time as you wish to complete the task.

Tracing 1:

.....

Tracing 2:

Please answer the following questions after you have completed the tracings:

1. Place a **tick** beside the traced signature that you believe is your best forgery.
2. Briefly describe the method/s you used to trace the signatures (continue overleaf if necessary):

3. Did you practice Tracing no. 1 before making your final attempt? YES: NO:
- 3a If you answered **YES**, for how long (approx.) did you practice? Hrs: _____ Mins: _____
4. Did you practice Tracing no. 2 before making your final attempt? YES: NO:
- 4a If you answered **YES**, for how long (approx.) did you practice? Hrs: _____ Mins: _____
5. Please state the approximate length of time it took to trace each of the signatures above?
Tracing 1: Hrs: _____ Mins: _____
Tracing 2: Hrs: _____ Mins: _____
6. What difficulties, if any, did you experience when making your tracings?

6. Do you notice any differences between the model signature and your tracings? Please describe these differences. [If you see no differences, please write 'none']:

Form 1a: SAMPLES OF YOUR NORMAL HANDWRITING

Please fill in ALL sections of this form in your NORMAL, day-to-day handwriting: If you make a mistake, please cross it out and continue.

NAME:.....

SIGNATURE:.....

DATE:
[DD/MM/YY]
TIME: r24hr1

Please copy the address below into Box A. The text should be copied exactly, paying special attention to capitals and lower-case letters as they occur:

BOX A:

Mr & Mrs W.E. James,
c/o Gold Medal Hospital,
X-Ray Department,
Lincoln Road,
Postal Zone 'B'
New York City,
N.Y., U.S.A.

[Empty box for copying the address into Box A]

Please copy the address again into Box B, using BLOCK CAPITALS only:

BOX B:

[Empty box for copying the address into Box B using block capitals]

APPENDIX VIII

Form 1b: SAMPLES OF YOUR NORMAL HANDWRITING

Please copy the passage below into Box C. The text should be copied exactly, paying special attention to capitals & lower-case letters as they occur.


Our London business is good but Vienna and Berlin are quiet. Mr. D. Lloyd has gone to Switzerland, and I hope for good news. He will be there for a week at 1396 Zermot St. and then goes to Turin and Rome and will join Col. Parry and arrive at Athens, Greece Nov. 27 or Dec 2. Letters there should be addressed: King James Blvd 3510. We expect Chas E Fuller on Tuesday. Dr. L. McQuaid and Robt. Unger, Esq. left on the 'Y.X. Express' tonight & paid £12.84 for tickets.

BOX C:



Please copy the passage again into Box D, using BLOCK CAPITALS only.

BOX D:



QUESTIONNAIRE

DISGUISED HANDWRITING

Please answer the following questions AFTER you have disguised your writing on Form 2:

Q1. Briefly describe the method/s you used to disguise your writing (continue overleaf if necessary):

Q2. Did you practice your disguise/s before making your final attempts? YES: NO:

Q3 If you answered **YES**, for how long (approx.) did you practice? Hrs: _____ Mins: _____

Q4. What difficulties, if any, did you experience when disguising your handwriting? [if none write none]

Q5a. Do you think that your disguised handwriting is unrecognizable to others and, therefore, unattributable to you? YES: NO: DON'T KNOW:

Q5b. Please give reasons why you answered *YES*, *NO* or *DON'T KNOW* to Question 5a.

QUESTIONNAIRE*

GENERAL

Please answer the following questions BEFORE completing the survey:

Q1 Gender: Male Female

Q2 Age: 18-25 26-35 36-45 46-55 56-65

Q3 Do you normally write with the: Left Hand Right Hand Either Hand

Q4a Do you suffer from any illness or disability that markedly affects your handwriting?

YES NO** **[If you have answered No, go to Q5]

Q4b If you answered Yes in Q4a, give brief details:

.....

Q5 Was your primary education (4-11 yrs.) in the UK? YES NO

Q6 Was your secondary education (12-18 yrs.) in the UK? YES NO

* The information that you provide will be entirely confidential & only used for analysing and interpreting data

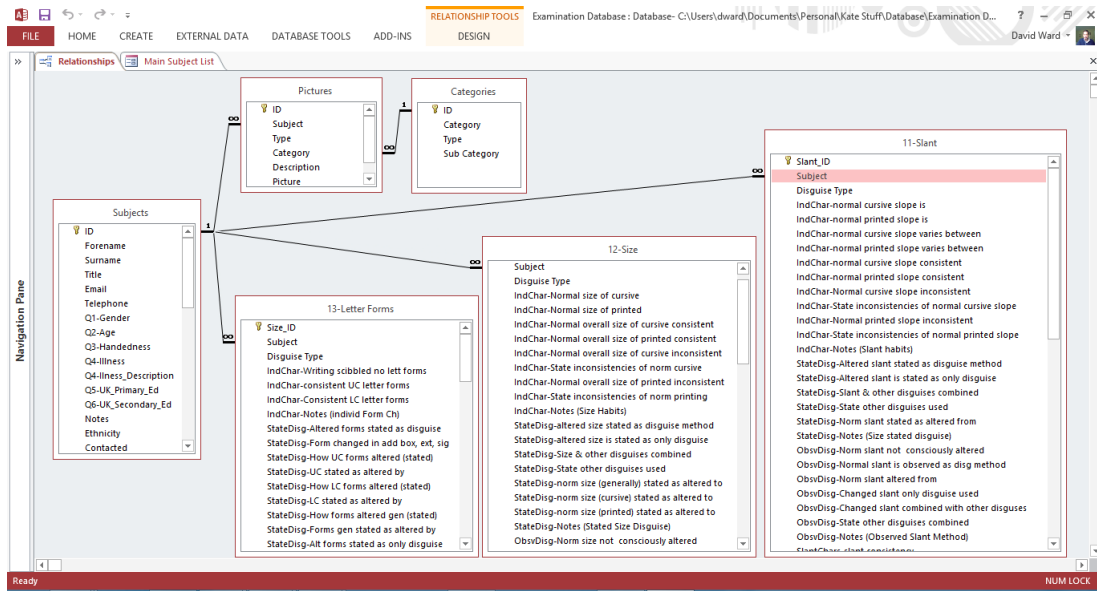
Database

In order to enter, store and retrieve the 1113 data points for each writing sample, a computerised database was developed using Microsoft Access 2010. A relatively simple database structure linked all the database tables to a single participant (subject) table which was used to store the details of each participant and their answers to the questionnaires. Due to the restricted number of fields that can be defined within a single table (255), and to simplify maintenance and data retrieval, a separate table was created for each group of data. In addition, two further database tables were included to enable example pictures and other notes to be stored and categorized for retrieval during the writing of the thesis. A list of the database tables is provided below:

- Subjects
 - Pictures
 - Categories
 - 11-Slant
 - 12-Size
 - 13-Letter Forms
 - 14-Baseline
 - 15-Strokes
 - 16-Extenders
 - 21-Speed
 - 22-Pressure

- 23-Re-Touching
- 24-Tremor
- 25-Hesitation
- 26-PenLift
- 27-BluntEnds
- 28-CurvesAngles
- 31-Arrangement
- 32-Spacing
- 33-Special Characters
- 34-Numerals
- 35-CrossBars
- 36-Connectors
- 37-Proportion
- 41-Unacustomed Hand
- 42-Looped
- 43-HandPrinting
- 44-CareSkill
- 45-Penhold
- 46-Omissions
- 51-Traced LineQuality
- 52-Traced Misc
- Additional Disguise Characteristics
- Filters
- Paste Errors

A screenshot of the database structure is provided below which shows Subjects, Pictures, Categories and three example data tables: Slant, Size and Letter Forms:



Each subject has two records in the tables related to tracing to allow data to be collected for each of the two traced signatures to be examined and two records in all of the other data tables to record results for the disguised extended writing and the disguised signatures.

User Interface

The objective of the database user interface design was to make the recording and validation of the handwriting analysis results as efficient as possible. The Microsoft Access 2010 Forms were used to provide a hierarchy of data entry screens that describes all of the information to be captured in a logical sequence and, where possible, to provide the available options to be

selected rather than free text entry in order to maximize consistency and to simplify the analysis of the results.

The main screen enables the participants’ names to be added, the status of each group of data collection to be maintained, answers to the questionnaire to be entered, and navigation to the data entry screens. A screen shot of the main subject list screen is provided below¹:

ID	Title	Surname	Forename	Inconsistent	Degenerate	Inconspicuous	Additional	Traced	Contacted	Confirmed	Sent	Received
93	Mr		Duane	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
71	Mrs		Heather	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
77	Mr		Tom	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
79	Mr		Nick	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
82	Mr		Marcus	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
86	Mr		Ryan	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
73	Mr		Andrew	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
72	Mrs		Kate	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
91	Mrs		Shirley	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
81	Mrs		Barbara	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
80	Mr		Noel	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
70	Mr		David	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
57	Mr		David	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
58	Mrs		Sue	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
78	Miss		Helen	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
85	Mr		Matt	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
66	Mr		Kevin	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
67	Mrs		Lesley	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
83	Mr		Hasan	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
61	Mrs		Christina	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
68	Miss		Lucy	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
76	Miss		Hannah	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
75	Mrs		Jackie	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
54	Mrs		Hazel	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
53	Mr		Jamack	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Total				30		30	30	30	1	30	30	30

Selecting a subject name provides the screen relating to questionnaire responses. A screenshot of this is provided below:

¹ To protect the anonymity of those who took part in the study, the names that appear in these screen shots are for illustration purposes only and do not represent the names of actual participants.

Selecting one of the buttons at the top of the screen displays the relevant group of data to be collected. Due to the large number of fields, the data forms are divided into tabs for each data group. An example data screen for Inconsistent Disguise, together with an example pull down field list box is provided below which shows how data is selected:

A full list of all the Forms (screens) and their hierarchy is provided below:

- Main Subject List
 - 1-Inconsistent Disguise
 - 11-Slant Subform
 - 12-Size Subform
 - 13-Letter Form Subform
 - 14-Baseline Subform
 - 15-Strokes Subform
 - 16-Extenders Subform
 - 2-Degenerate Line Quality
 - 21-Speed Subform
 - 22-Pressure Subform
 - 23-Re-Touching Subform
 - 24-Tremor Subform
 - 25-Hesitation Subform
 - 26-PenLift Subform
 - 27-BluntEnds Subform
 - 28-CurvesAngles Subform
 - 3-Inconspicuous Details
 - 31-Arrangement Subform
 - 32-Spacing Subform
 - 33-Special Characters Subform
 - 34-Numerals Subform
 - 35-CrossBars Subform
 - 36-Connectors Subform
 - 37-Proportion Subform

- 4-Additional
 - 41-Unacustomed Hand Subform
 - 42-Looped Subform
 - 43-HandPrinting Subform
 - 44-CareSkill Subform
 - 45-Penhold Subform
 - 46-Omissions Subform
- 5-Traced
 - 501-Traced LineQuality
 - 502-Traced Guidelines
 - 503-Traced Superimposition
 - 504-Traced FineDetail
 - 505-Traced LineDirection
 - 506-Traced OverExtension
 - 507-Traced Alignment
 - 508-Traced ExMarks
 - 509-Traced Size
 - 510-Traced Slant
 - 511-Traced IndivChar
- Disguise Pictures
 - Pictures_Detail Subform
 - Pictures_List Subform
- Categories
- Filter Details

Data Reporting and Analysis

It was impractical to develop reports using Microsoft Access 2010 to display all the different views for the large number of data fields, therefore a Microsoft Excel 2010 spreadsheet was linked to the database to enable pivot tables to be easily created in order to view each data group. An Excel worksheet was created and linked to each data table. See example screenshot below:

Forename	Surname	Slant ID	Subject ID	Disguise Type	Normal cursive slope is:	Normal printed slope is:	Normal cursive slope varies between:	Normal printed slope is:
Barbara		35	81	Disguised Writing	Extreme Forehand	Forehand		
Barbara		34	81	Disguised Signature	Forehand	Forehand		
		25	82	Disguised Signature	Backhand			
Marcus		24	82	Disguised Writing			V, FH & BH	V, FH & BH
Hasan		53	83	Disguised Writing	Vertical	Vertical		
Hasan		52	83	Disguised Signature	Vertical			
Matt		47	85	Disguised Writing	Vertical	Vertical		
Matt		46	85	Disguised Signature	Vertical			
Ryan		27	86	Disguised Writing	Vertical	Vertical		
Ryan		26	86	Disguised Signature	Vertical			
Elizabeth		66	87	Disguised Signature	Backhand			
Elizabeth		67	87	Disguised Writing	Backhand	Backhand		
Shirley		32	91	Disguised Writing	Vertical	Vertical		
Shirley		33	91	Disguised Signature	Vertical			
Duane		16	93	Disguised Writing	Vertical	Vertical		
Duane		17	93	Disguised Signature	Vertical			
James		65	53	Disguised Writing	Vertical	Vertical		
James		64	53	Disguised Signature	Vertical			
Hazel		62	54	Disguised Signature	Backhand	Backhand		
Hazel		63	54	Disguised Writing	Backhand	Backhand		
David		40	57	Disguised Signature			V & BH	
David		41	57	Disguised Writing	Backhand			V & BH
Sue		43	58	Disguised Writing	Backhand	Backhand	V & BH	
Sue		42	58	Disguised Signature	Backhand			

A number of pivot tables were created to provide various summary views of the data contained in each of these worksheets. These pivot tables were in turn grouped together into the following 6 additional summary worksheets:

- Inconsistent Disguise
- Degenerated Line Quality

- Inconspicuous Details
- Additional
- Disguise Method
- Disguise Method Combinations

The 200 pivot tables contained in these 6 summary worksheets were used to analyze and report research results. A screenshot of 16 of the 60 pivot tables in the Inconsistent Disguise worksheet is provided below:

