Research Article

IJCRR
Section: General Science
Sci. Journal Impact Factor 4.016
ICV: 71.54

Determination of Sex Through Handwriting Characteristics

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ABSTRACT

Aim: The aim of this study is to determine the gender of an individual by handwriting

Methodology: In this study total 130 handwriting samples were collected and analyzed. In which 65 males and 65 female volunteers of age group 18 to 30 years were selected. Handwriting samples are taken on A-4 Size paper of London Letter. Exclusive factors in this study are only literate, young & healthy persons are included.

Result: Macro features and micro features were examined in all the 130 handwriting samples in both male and females by using feature extraction method and z-tests. In the second method which is Hypothesis testing done by z-test, Null hypothesis was taken that "there is no significant difference in male and female handwriting " and on the basis of value of z in table-2 at 5% level of significance with critical value of 1.96, out of 27 features for which z-test was performed, Seven features could said to be gender identifying features and may help in identifying the gender of the writer.

Conclusion: On the basis of above result, feature extraction and z-test may said to be the two methods which may explain about the utility of these tests for examination of hand writing for gender identifying feature. It can be said that there is a significant differences between hand writing of male and female and hence a handwriting sample can also be examined for gender identification purpose.

Key Words: Handwriting, Gender, Natural variation, Macro features, Question document

INTRODUCTION

Documents play important role in human life. A document is material, having a symbol or writing on it, which conveys some meaning to one or persons. It may be stone, a wall, a wooden piece, a glass, a metal sheet a skin, a piece of cloth, a parchment or a paper. We daily write and sign a number of documents, like a person letter, a receipt, a cheque, or an order affecting the lives of many individual [1]. With the increasing use of documents in day to day life its misuse has also increased to the utmost level people due to its falsification which has now been grow to a big economical source whether it is beyond the laws and illegal. When it comes to the criminal justice system the false or forged document becomes a questioned. Questioned documents defined as "Any Document about which some issue has been raised or that is the subject of an investigation[2]. Handwriting is one of the important evidence which is examined in the questioned document for its authentication handwriting may be defined as written speech of individual with characteristic peculiar to himself intending to difference from all other. By studying and examining the handwriting in suspected and the victim.

A person's handwriting changes over the course or his or her life time.[3] Apart from above explained characteristics, handwriting may be differentiated in the basis of various natural variations such as illness, age writing materials, writing position, physical disturbance, lack of concentration during the writing period, influence of alcohol or drug[3] .Research shows a consistent relationship with handwriting is the determination of sex of handwriting .[4] Western reports of handwriting shows that female handwriting has greater circularity.[4,5,6,7,8]

One contender for conceivable impact is the impact of androgens that ""masculine"" behavior and possibly neural substrates during the critical pre-birth period. A particularly sensitive period when there is an expansion in androgens is from 7 to 24 weeks with an ideal level in the eighteenth week .[9]

21 segregating components in handwriting are distinguished. Analyzing shape variations of each letter (called allographs)

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ISSN: 2231-2196 (Print) **ISSN:** 0975-5241 (Online) **DOI:** 10.7324/IJCRR.2017.9133

Received: 26.05.2017 **Revised:** 06.06.2017 **Accepted:** 20.06.2017

can be valuable, however word development is similarly if not more critical for investigations, for example, gendering a writer based on handwriting : specifically, word arrangement in cursive written work tends to "convey" more independence and examples than individual letter shapes. [3,10]

A characteristic specimen contains just habits and natural variations .Factors in penmanship vary as far as the recurrence of natural variations (or the level of characteristic variety as on account of proportion factors) [11,12,13.]

Area of Study

The study was conducted in the area of Bilaspur district of Chhattisgarh. and sampl collection was done within the area of Guru Ghasidas Vishwavidyalaya, Bilaspur.

Methodology

Sampling: Total 130 handwriting samples were collected. 65 from males and 65 from female volunteers, from the higher secondary, graduated or post graduated working individuals between the age group of 18 to 30 years. All the personal details of volunteers is firstly noted down in the white sheet of paper which contains Name, Sex, Date of birth ,Education ,Occupation, Handedness and Local address. Handwriting samples are taken on A-4 Size paper of London Letter. Exclusive factors in this study are only literate, young & healthy persons are included.

Volunteers were asked to sit straight and copy the given London Letter and everyone is asked with their normal speed neither too slow nor too fast on a stable flat table and chair in adequate amount of light. Two methods were employed for the examination of gender identifying features in handwriting samples of male and female volunteers.

Feature Extraction:

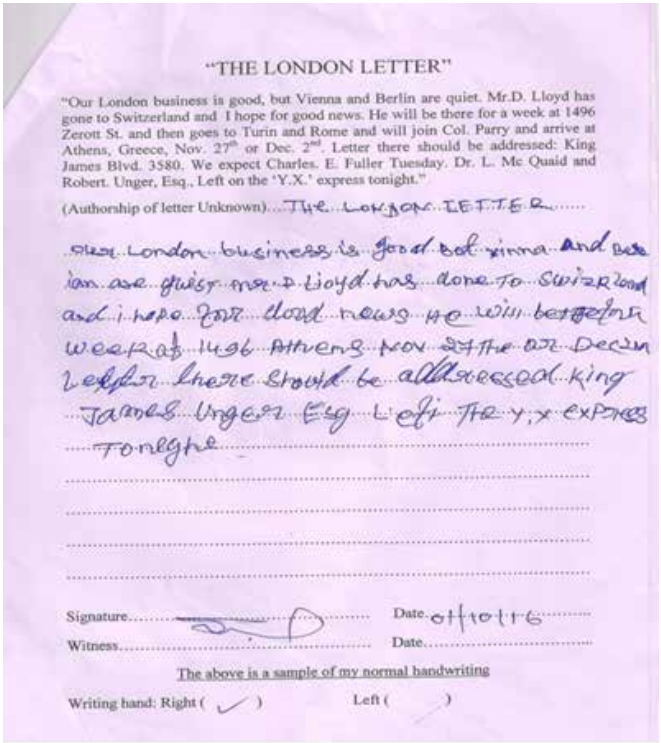
1. Each sample was analyzed for presence of total 27 features of handwriting which were divided in two groups Macro features and Micro features. These features were studied for identifying any discrimination on the basis of their presence and absence in both males and females handwriting.[4] Macro feature: Macro features are those which can be observed superficially without any thorough search in the handwriting. Slant Word spacing Dispersive writing

Cursive writing

Micro feature: Micro features are those which are needed to be examined carefully for their presence in the sample,

Micro feature – Dot over "i"
Hook at the start of "c"
Hook at the end of "c"
Hook at the end of "d"
Hook at the end of "e"
Hook at the end of "h"
Hook at the end of "u"
Loop formation in stem letter "b"
Loop formation in stem letter "d"
Loop formation in stem letter "h"
Flourish at the start of "a"
Flourish at the start of "c"
Flourish at the start of "d"
Flourish at the start of "o"
Flourish at the start of "u"
Consistency in angle of crossbar on "t"
Consistency in angle of crossbar on "f"
Consistency in "X"
Shape of "r"(acrade)
Shape of "r" (parochial)
Knot formation n the
End of "w"
Straight down stroke formation in "y"
Angular base of letter "w"
Point base of "w"
Upward flourish letter "s"

Apart from above explained characteristics, handwriting may be differentiated on the basis of variation due to age, illness, education ,fatigue, physical and emotional disturbance, disease, or drug intoxication[3].


"THE LONDON LETTER"

"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 1496 Zerott St. and then goes to Turin and Rome and will join Col. Parry and arrive at Athens, Greece, Nov. 27th or Dec. 2nd. Letter there should be addressed: King James Blvd. 3580. We expect Charles. E. Fuller Tuesday. Dr. L. Mc Quaid and Robert. Unger, Esq., Left on the 'Y.X.' express tonight."

(Authorship of letter Unknown)....THE LONDON LETTER.....

Dear London business is good but Vienna And Berlin are quiet Mr.D Lloyd has done To Switzerland and i hope for good news He will be there for a week at 1496 Athens Nov 27th or Dec 2nd Letter there should be addressed King James Unger Esq Left the Y.X express Tonight

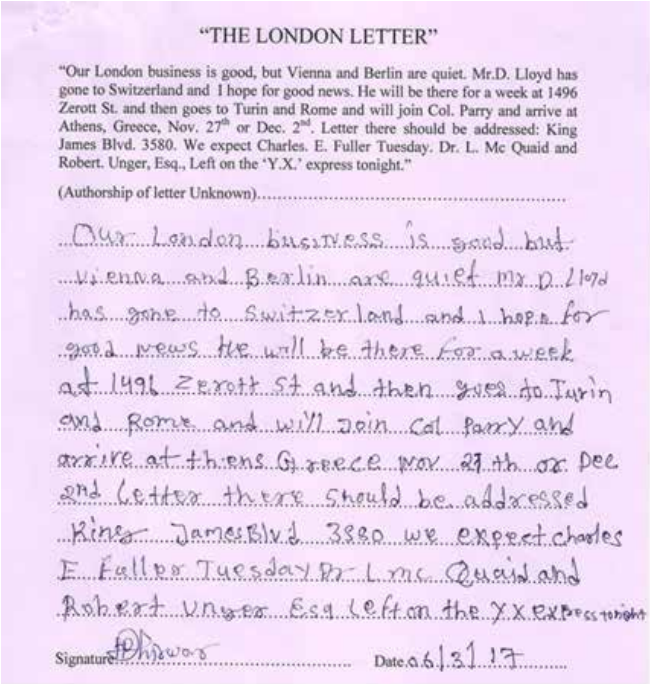
Signature..... Date. 07/10/16

Witness..... Date.....

The above is a sample of my normal handwriting

Writing hand: Right (✓) Left ( )

Figure 1.1: Handwriting of low skilled Person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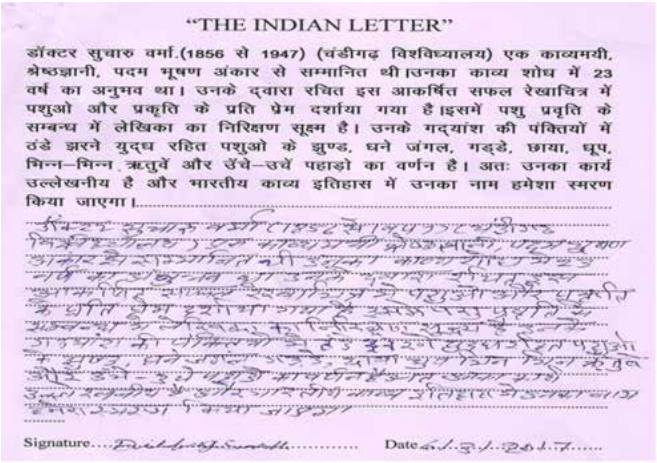
Signature..... Date 06/21/17

Figure 1.2: Handwriting of person in Depression


"THE INDIAN LETTER"

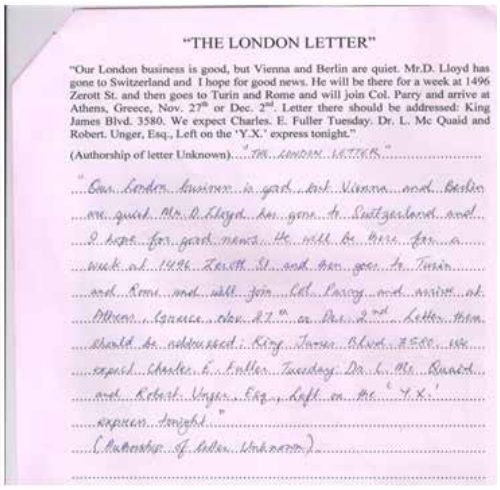
डॉक्टर सुधारु वर्मा.(1856 से 1947) (चंडीगढ़ विश्विध्यालय) एक काव्यमयी, श्रेष्ठज्ञानी, पदम भूषण अंकार से सम्मानित थी।उनका काव्य शोध में 23 वर्ष का अनुभव था। उनके द्वारा रचित इस आकर्षित सफल रेखाचित्र में पशुओ और प्रकृति के प्रति प्रेम दर्शाया गया है।इसमें पशु प्रवृति के सम्बन्ध में लेखिका का निरिक्षण सूक्ष्म है। उनके गद्यांश की पंक्तियों में ठंडे झरने युद्ध रहित पशुओ के झुण्ड, घने जंगल, गड्ढे, छाया, धूप, भिन्न–भिन्न ऋतुवें और उँचे–उचें पहाड़ो का वर्णन है। अतः उनका कार्य उल्लेखनीय है और भारतीय काव्य इतिहास में उनका नाम हमेशा स्मरण किया जाएगा।.....

Signature..... Date.....

Figure 1.3: Handwriting of Alcoholic Person


"THE LONDON LETTER"

2.1 Vertical type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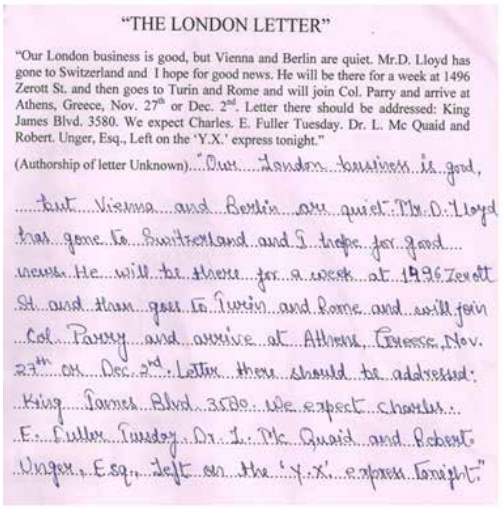
2.2 Right side leaned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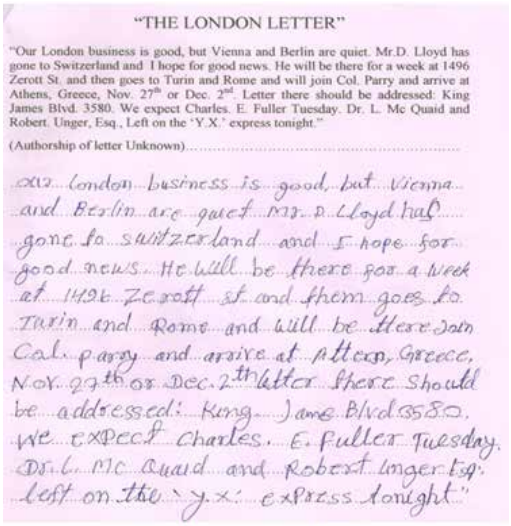
2.3 Left side slant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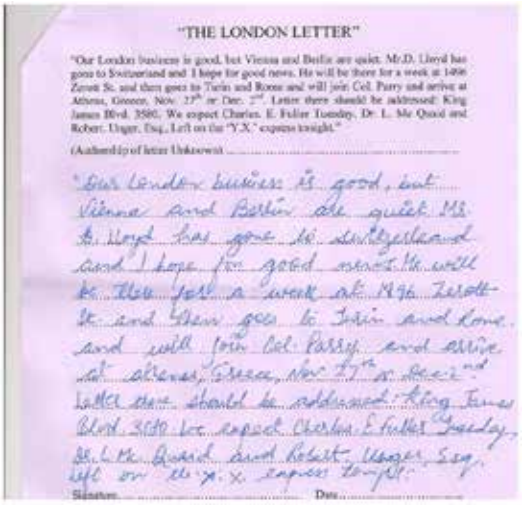
3.1 Dispersive Type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Signature ..... Date .....

3.2 Cursive type of writing

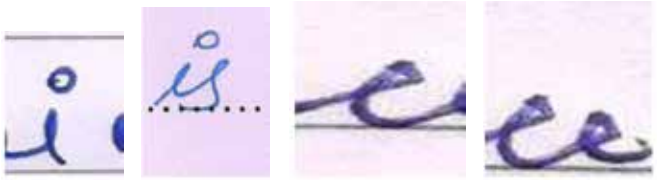

Figure 4: dot of " i" **Figure 5**: circular dot of " i" **Figure 6**: hook at start of "c" **Figure 7:** hook at the end of "c".

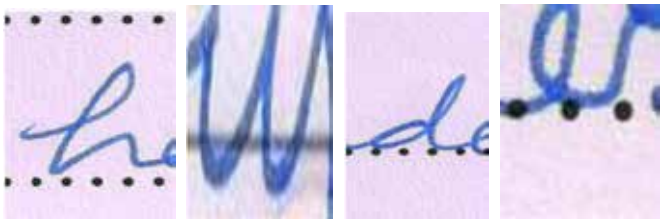

Figure 8: hook at end of " d" **Figure 9:** hook at the end of " e" **Figure 10:** hook at end of "h" **Figure 11:** hook at endof "u".

Figure 12: loop in stem of " b" **Figure 13:** loop in "d" **Figure 14:** loop in stem of "h" **Figure 15:** flourish at start of "a".

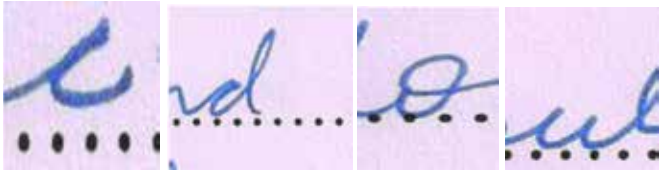

Figure 16: flourish at start of "c" **Figure 17:** flourish at start of "d" **Figure 18:** flourish at the start of "o" **Figure 19:** flourish at the start of " u".

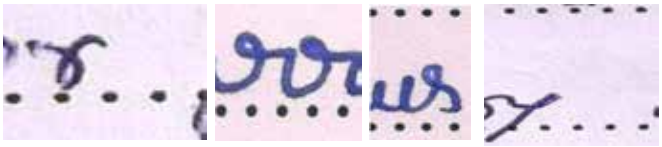

Figure 20: shape of "r"(acrade) **Figure 21:** shape of "r"(parochial) **Figure 22:** knot in "w" **Figure 23:** straight stoke of "y".

Figure 24: angular base of " w" **Figure 25:** pointed base of "w" **Figure 26:** upward flourish "s"

2. Slant of the writing were observed keeping the handwriting sample at 90° angle to the eye, it was either leaned to the right or left hand side or simply be vertical.
3. Spacing between words was calculated by using plastic ruler in centimetre unit of length. Overall 49 spaces were present in the given standard text and hence mean value of all the spacing was calculated . It may vary in each sample of handwriting. Mean=Total length of all the spacing between the words in (cm) / Total no. of spaces present.
4. Type of handwriting was observed , whether it was distributed or scattered form called as Dispersive writing. In this, usually letters are separated apart from each other in each word lacking connecting strokes and flourishes.
5. Next macro feature which was observed was the Cursive type of handwriting. It was the most beautiful and presentable form of writing in which lots of flourishes and connecting stroke are seen . It also tells the skill and education level of its writer.
6. Then micro features were observed in which first comes the dot over letter "i" which may be either circular in shape or pointed. When both type of dot was present then the type which was present more in number in overall writing was considered.
7. Hook like formation was then observed and counted in start and end of letter c,d,e,h and u.
8. Loop in the letter b,d and h was observed.
9. Then flourishness at the start of letters a,c,d,o and u was observed and counted.
10. Overall consistency in the crossbar in the letter "t and f was observed. Then consistency in the shape of letter x was noted down.
11. Shape of letter r in small was observed and counted for being arcade or parochial
12. In some handwriting a small circular or little oblong knot was found in the end of letter "w" which was observed and noted down.
13. Letter "y" may be straight in its lower stem or slanted

, hence it was observed in both the male.

14. Base of the letter "w" was observed for being angular or pointed in appearance.
15. Last micro feature observed was the presence of upward flourish in letter "s".
16. After observation and counting of each feature their overall percentage were calculated in 65 samples of male handwriting and 65 samples of female handwriting.
17. Based on all the observations and values obtained a table and graph were formed.

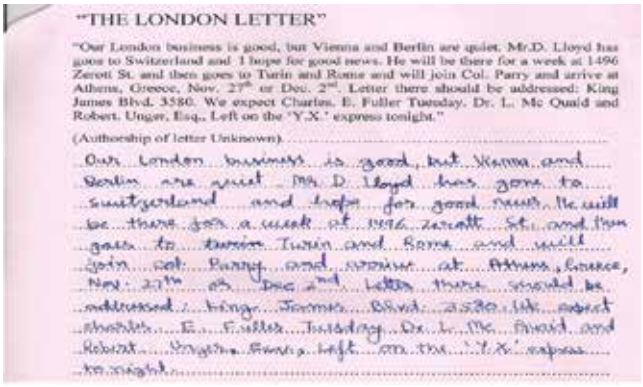

Figure 27.1: Handwriting sample of boy showing bold and heavy pen pressure of writing instrument.

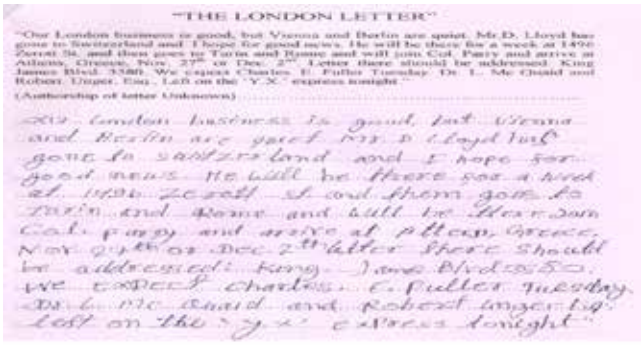

Figure 27.2: Handwriting sample of boy showing dispersive type of handwriting and heavy pen pressure was observed.

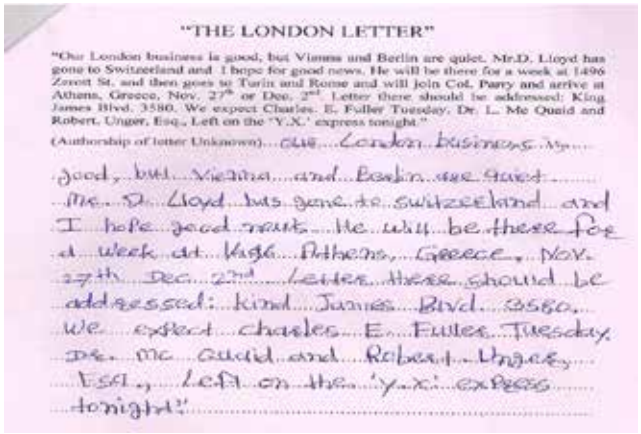

Figure 27.3: These male handwriting samples shows un presentable and dispersive type of writing and heavy PP.

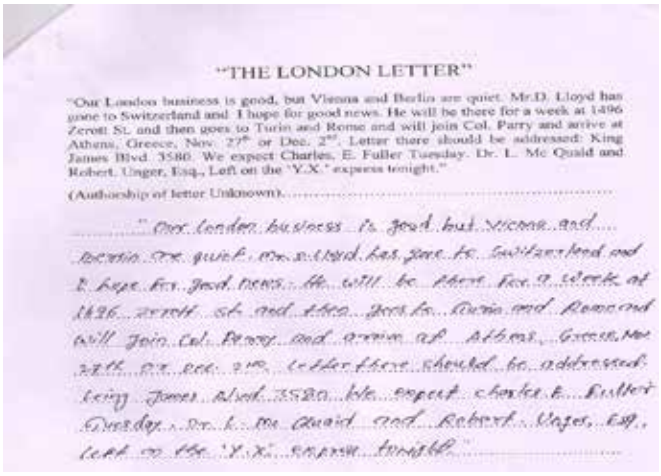

Figure 28.1: Handwriting sample of female with less pen pressure and rounded shape letters are more.

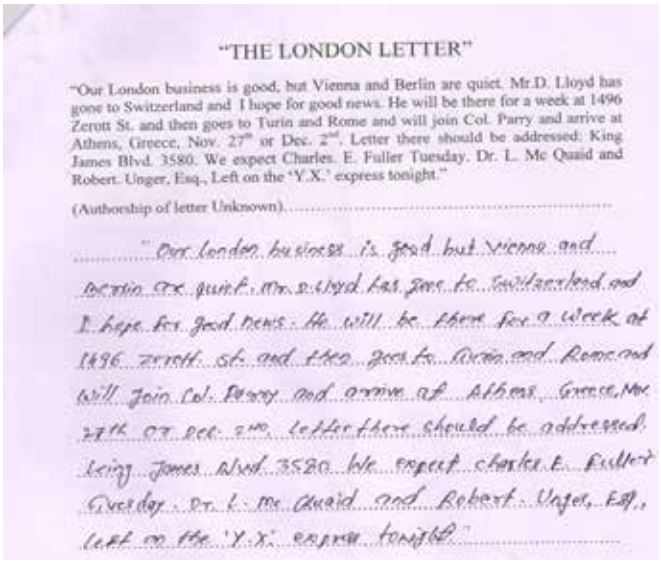

Figure 28.2: this handwriting sample of female also posses lesser pen pressure than the male rounded and free use of pen and highly slanted.

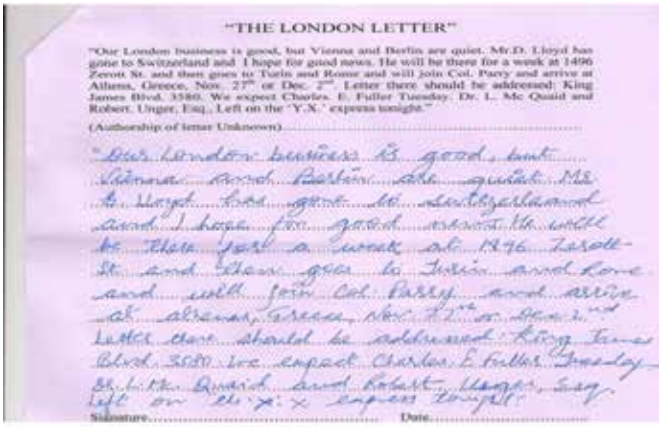

Figure 28.3: Handwriting samples of females were decorative and presentable proper spacing between letters and words were mostly found.

Hypothesis Testing and Z- Test

Hypothesis may be defined as a proposition or a set of proposition set forth as an explanation for the occurrence of some specified group of phenomena either asserted merely as a provisional conjecture to guide some investigation or accepted as highly probable in the light of established facts. Hypothesis testing enables us to make probability statements about population parameter . The hypothesis may not be proved absolutely, but in practice it is accepted if it has withstood a critical testing . Alternative hypothesis is usually the one which one wishes to prove and null hypothesis is the one which one wishes to disprove . Thus, a null hypothesis represents the hypothesis we are trying to reject , and alternative hypothesis represents all other possibilities. Generally, in hypothesis testing we proceed on the basis of null hypothesis, keeping the alternative hypothesis in view , on the assumption that null hypothesis is true, one can assign the probabilities to different possible sample results , but this cannot be done if we proceed with the alternative hypothesis. Hence the use of null hypothesis is quite frequent.

The level of Significance : This is a very important concept in the context of hypothesis testing. It is always some percentage(usually 5%) which should be chosen with great care thought and reason. In case we take the significance level al 5 percent, then this implies that null hypothesis will be rejected . z- test is based on the normal probability probability distribution and is used for judging the significance of several statistical measures, particularly the mean. This is a most frequently used test in research studies(5).

p1 = X1/n1 p1-proportion of male handwriting samples where the features occurs

samples w here the feature p2= X2/n2 p2 – proportion of female handwriting samples where the features occurs

X1, X2 - frequencies of feature in males and females respectively

n1, n2- no. of samples of male and females handwriting respectively

z = 1.96(10)

1. Null hypothesis was stated that "there is no significant difference in handwriting of male and female" .
2. p1 and p2 value were calculated separately for each of the feature in male and female handwriting. 3. By keeping all the obtained values in the formula, z-test was performed and thus values obtained were noted down. 4. Thus all the obtained values were tabulated.

RESULT AND DISCUSSION

Data was obtained from 130 handwriting samples of male and females. Macro features and micro features were examined in all the 130 handwriting samples in both male and females by using feature extraction method and z-tests. Two macro features that are slant and word spacing were also observed. Slant was observed to be either right sided , left sided or vertical in which 17 samples were in Right, 20 in left and 43 in vertical positions in males whereas in female 25 were in right 11 in left and 31 in vertical position out of 65 . In case of word spacing both male and female samples were having Mean of word spacing, O. 35cm-0.96cm and 0.34-0.92cm hence there was no significant difference was observed in the case of word spacing as range was near about similar in both. Whereas in the case of slant (macro feature) males were observed to be possessing slant in their writing in left and vertical position more than females on the other hand females were observed to be possessing slant in right hand side as compared to males . This could be used as one of the point in discriminating the handwriting samples on the basis of slant.

On the basis of the study of table-1, out of 27 characteristics feature of handwriting 11 feature i.e. Dot over "i" Straight down stroke formation of letter "s", angle of crossbar on "f","t", flourish at letter "o", loop in stem of letter"d", hook at end of "u", " h", and hook at start and end of letter "c" and cursive type of writing were observed to be showing significant role in discrimination of male and female handwriting on the basis of their occurrence which was half in one sample and double on the other.

In the second method which is Hypothesis testing by z-test, Null hypothesis was taken that "there is no significant difference in male and female handwriting " and on the basis of value of z in table-2 at 5% level of significance with critical value of 1.96, out of 27 features for which z-test was performed, 7 showed value of z more than the critical value 1.96 i.e. cursive writing Dot over letter "i" , Hook at the end of letter "c", Loop formation in stem of letter "d", Flourish at start of letter "d", Consistency of angle of crossbar on "t" and Straight down stroke formation in "y". Hence in these 7 features null hypothesis was rejected and alternate hypothesis was accepted that there is a significant difference in handwriting of male and female . These seven features could said to be gender identifying features and may help in identifying the gender of the writer.

Table 1: Presentation of Percentage of Occurrence of Handwriting Feature in Male and Female

S.N.	Characteristic Features	% In Male	% In Female
1.	Macrofeature Dispersive writing	96	89
2.	Cursive writing	3	11
3.	Micro feature – Dot over "i"	84.6	69
4.	Hook at the start of "c"	9	18
5.	Hook at the end of "c"	4	14
6.	Hook at the end of "d"	23	20
7.	Hook at the end of "e"	7	12
8.	Hook at the end of "h"	4	37
9.	Hook at the end of "u"	4	37
10.	Loop formation in stem letter "b"	7	6
11.	Loop formation in stem letter "d"	17	28
12.	Loop formation in stem letter "h"	15	18
13.	Flourish at the start of "a"	34	32
14.	Flourish at the start of "c"	23	22
15.	Flourish at the start of "d"	35	42
16.	Flourish at the start of "o"	45	34
17.	Flourish at the start of "u"	31	29
18.	Consistency in angle of crossbar on "t"	78	60
19.	Consistency in angle of crossbar on "f"	84	72
20.	Consistency in "X"	89	88
21.	Shape of "r"(acrade)	54	56
22.	Shape of "r" (parochial)	46	54
23.	Knot formation n the End of "w"	21	17
24.	Straight down stroke formation in "y"	46	25
25.	Angular base of letter "w"	92	91
26.	Point base of "w"	7	11
27.	Upward flourish letter "s"	50	54

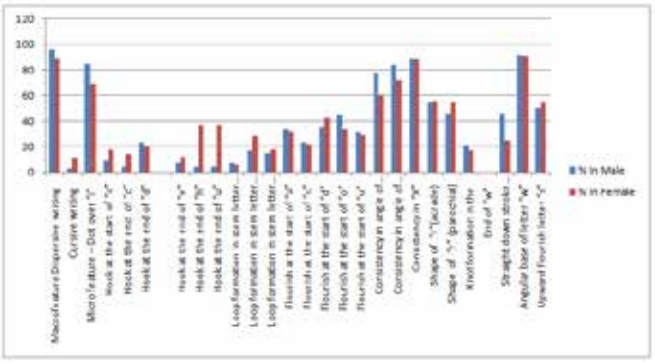

Figure 29: Distribution of feature in percentage for male and female of gender identifying features.

Table 2 : Value as of Hypothesis and Z –T est

S.N.	Characteristic Features	p1	p2	Z - value
1.	Macro feature Dispersive writing	0.96	0.89	1.5
2.	Cursive writing	0.03	0.10	-2.3
3.	Micro feature – Dot over "i"	0.84	0.69	2.04
4.	Hook at the start of "c"	0.09	0.18	-1.6
5.	Hook at the end of "c"	0.04	0.13	-3
6.	Hook at the end of "d"	0.23	0.2	0.42
7.	Hook at the end of "e"	0.07	0.12	-1.25
8.	Hook at the end of "h"	0.4	0.36	0.57
9.	Hook at the end of "u"	0.4	0.36	0.57
10.	Loop formation in stem letter "b"	0.07	0.06	0.3
11.	Loop formation in stem letter "d"	0.1	0.27	-2.83
12.	Loop formation in stem letter "h"	0.15	0.18	-0.5
13.	Flourish at the start of "a"	0.33	0.32	0.14
14.	Flourish at the start of "c"	0.23	0.21	0.28
15.	Flourish at the start of "d"	0.35	0.14	3
16.	Flourish at the start of "o"	0.44	0.33	1.3
17.	Flourish at the start of "u"	0.30	0.29	0.14
18.	Consistency in angle of crossbar on "t"	0.78	0.6	2.5
19.	Consistency in angle of crossbar on "f"	0.84	0.72	1.2
20.	Consistency in "X"	0.89	0.87	0.14
21.	Shape of "r"(acrade)	0.53	0.46	0.87
22.	Shape of "r" (parochial)	0.46	0.53	-0.8
23.	Knot formation n the End of "w"	0.21	0.16	0.83
24.	Straight down stroke formation in "y"	0.46	0.24	3.14
25.	Angular base of letter "w"	0.92	0.90	045
26.	Point base of "w"	0.07	0.	-0.68
27.	Upward flourish letter "s"	0.50	0.53	-0.37

CONCLUSION

On the basis of above result, feature extraction and z-test may said to be the two methods which may explain about the utility of these tests for examination of hand writing for gender identifying feature. Those characteristics feature which showed positive result in the examination of 65 samples of male and female may be considered as gender identifying features.

It can be said that there is a significant differences between hand writing of male and female and hence a handwriting sample can also be examined for gender identification purpose. So it can be considered as a corroborative evidence in the field of questioned document examination .[14]

Significance in forensic science

Examination of handwriting and graphology has always been of great utility in forensic science not only as a source of physical evidence in criminal investigation but also for evolving new techniques and idea related to the purpose of personal identification if it becomes possible to predict the gender of the writer or forger along with his age so the innocent could be protected and hence it may speed up the investigation process.

Future aspects

Examination of handwriting for gender identifying feature for gender discrimination may be evolved as a great area for research studies in future. With the growth of new ideas and technologies the methods of examination has been evolved from manual to computerized automatic methods of examination has been evolved from manual to computerized automatic methods involving use of various software which may easily identify the gender identifying features in the handwriting and predict the gender within a minute or seconds.. This will not only reduce the human labor, cost and risk of error but also increase the chances of positive and best outcome in every large population size.

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