Research Journal of Forensic Sciences ISSN 2321–1792
Vol. **8(2),** 9-19, July **(2020)** *Res. J. Forensic Sci.*

Determination of the hand of the writer based on Handwriting characteristics

Mohit Mann, Shivani Patel, Vaishali Awasthi, Chaitanya Vats and Surbhi Mathur*
Institute of Forensic Sciences, GFSU Gandhinagar, India
surbhi.mathur@gfsu.edu.in

Available online at: www.isca.in, www.isca.me
Received 21st May 2020, revised 28th June 2020, accepted 27th July 2020

Abstract

Handwriting is a complex act and a highly developed skill. Many influences affect the development of each person's handwriting ability, bringing about one of the kind and unique style of each individual writer. When in any case, involving handwriting arises, document examiners need to use a systematic approach for determining the authorship of the document. Additionally, the differentiation in the handedness of the writer can narrow down the suspect list and can form a corroborative evidence. To study the differentiation and to compare left-handed writing with right-handed writing, the present study was conducted at GFSU, Gandhinagar. 100 handwriting samples of subjects falling in age group of 18-30 years, 50 of right-handed writer and 50 of left-handed writer were selected given standard content for writing three times on blank A4 sheet with blue ball point pen. A significant difference was noted in the characteristic features like staffs, strokes, slopes and word formation of characters in left-handed and right-handed writing.

Keywords: Handwriting, Staff, Slope, Stroke, Writer, Left-handed, Right-handed.

Introduction

Handwriting is aunique for every individual and have their own personal style of writing. It is made by an individual with the assistance of a composing instrument, for example, pen or pencil. Handwriting is unique and individual to its own. It is an acquired skill and a complex task of brain and arm muscles. Handwriting is a result of rigorous practice. When a person writes onto a surface using an instrument, the imprint of the letters in his mind is reflected on the writing surface with the help of neuromuscular coordination[1]. Handwriting is a combination of letters, symbols or characters with a writing instrument to create a recognizable pattern in order to communicate or implies any kind of information to the other person. Each writer got some intrinsic exceptional forces, capacity for graphical expressions and few technical expressions. It takes long time of thorough practice to build up an able penmanship. Realistic development in handwriting is reached when the neuromuscular coordination abilities of an individual are entirely developed. Writing is a complex act and a highly developed skill[1]. Many influences like age, medical condition, injury etc., affect the development of each person's writing ability, resulting in the unique style of each individual writer. These influences continue to occur throughout the life of the writer.

In right-handed author, the formation of letter takes place from left to right, they can easily see the execution of letters on the writing surface[2]. The left-handed author must alter the position their hand in order to catch sight of what they are writing[3]. It is said that the author who use right hand for writing makes strokes from left side to right side[4]. While in left-handed author it is assumed that the execution of specific characters and making of strokes takes place from right to left[5]. Specific characters in a person handwriting can be examined to find out the handedness of the author. Samples collected from both left and right-handed individuals show significant differences in some characteristic features such as slope, writers who write with right hand make forward slope while in the writing samples of left-handed authors backward slope is observed. Samples of Right-handed authors and left-handed authors were investigated for finding variations in characteristics like slope and strokes. Special characteristic features were examined in both left-handed authors and right-handed authors like 'i' –dot ,head and base stroke of 'I', head stroke of letter 'T', cutting stroke of 't', vertical staff of letter 'h', 'b', joining of stroke of letter 'A', 'H', slant of letter 'd', 't', 'g', 'y'. Head stroke of letter 'F', 'E', and direction of the making of letter 'o'. The significant level of variations in the formation selected characteristic features and characters was detected among the left-handed authors and right-handed authors. It is an important goal of Forensic studies to identify the group attributes of writer like gender, age, handedness from their handwriting. With the help of this study a forensic questioned document examiner can eliminate various suspects after thorough analysis of their handwriting samples which would be helpful in smooth and proper investigation.

Methodology

For this study, 100 subjects were selected and from each subject 3 samples were collected making total samples 300. Population selected was from colleges and offices of Gandhinagar, Gujarat

in which 50 subjects were left-handed and another 50 subjects were right-handed. Age group of all the subjects was between 18 years to 30 years. Examinees were told to sit with straight back and copy the given content in English. White blank A4 sheet was given with blue ball point to write the sample under normal conditions without any external pressure on flat table with chair under adequate light source. The collected writing samples were examined by magnifying lens and stereomicroscope. In samples characteristic features like stroke of 'T', 't', 'I', 'A', 'H', 'F', 'E' were observed under stereomicroscope, Slant of 'd', 'g', 'y', 't' was observed visually and formation of 'i'-dot, 'o' was also observed under stereomicroscope. Then the average of three samples of individual was calculated for each characteristic feature and obtained data was further used for Chi square analysis to signify the value of characteristics in elimination of suspects in various questioned document cases. Chi square was calculated through Statistical Package for the Social Sciences (SPSS) software.

Results and discussion

In the present study, result shows that various characteristics are significant in decoding the handedness of the writer in various document related cases which is further supported by the Chi square test. And results are furnished in the Tables 1-15 along with their associated Figures-1-15 for each alphabet selected for this research.

Table-1: 5x2 contingency table for formation of 'i' dot (total, N=100; df=4).

Hand	Circular	Dot	Centre to bottom	Centre to left	Centre to right
Left	12	8	21	1	8
Right	24	8	8	0	10

Null hypothesis (H_0) = formation of 'i' dot is independent of hand of writer, Alternate hypothesis (Ha) = formation of 'i' dot is dependent of hand of writer.

The chi square value for formation of 'i' dot in all the handwriting specimens was 11.0498 ($p<0.05$; df=4; $p=0.02601$). It was found to be significant at alpha = 0.05, dismissing the null hypothesis and adopting the alternate hypothesis for the formation of 'i' dot is dependent of hand of writer.

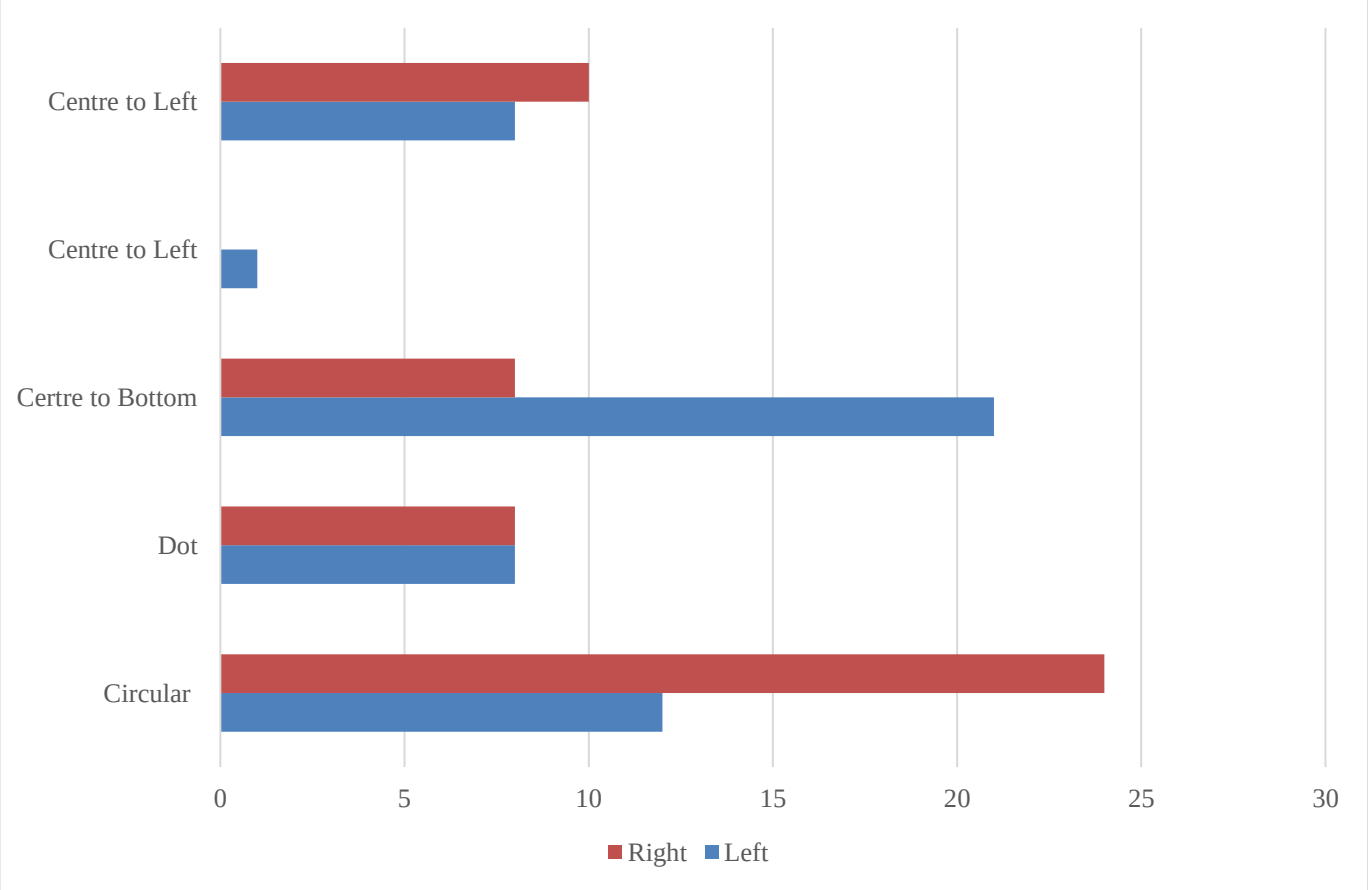

Figure-1: for 'I' dot.

The chi square value for formation of head and base stroke of letter 'I' in all the handwriting specimens was 22.3452 ($p<0.05$; df =2; $p=0.000014$). It was found to be significant at alpha = 0.05 dismissing the null hypothesis and adopting the alternate hypothesis for the formation of head and base stroke of letter I is dependent of hand of writer.

Table-2: 3x2 contingency table for head and base stroke of letter 'I' (total, N=100; df=2)

Hand	Left to right	Right to left	Without bar
Left	27	17	06
Right	46	0	04

Null hypothesis (H_0) = formation of head and base stroke of letter 'I' is independent of hand of writer, Alternate hypothesis (Ha) = formation of head and base stroke of letter 'I' is dependent of hand of writer.

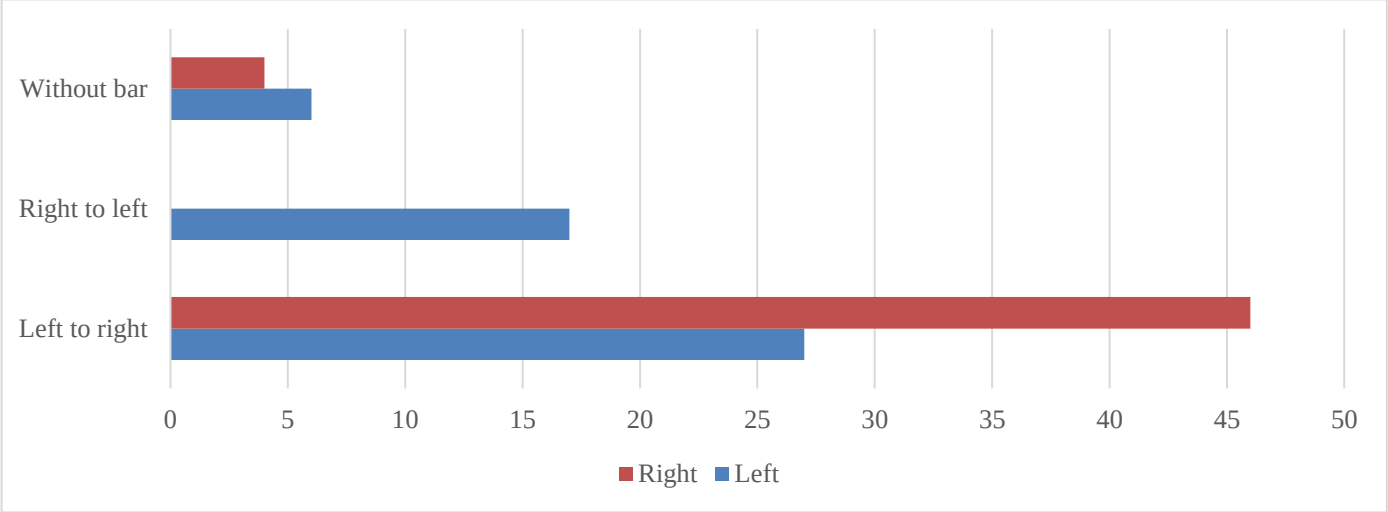

Figure-2: For head and base stroke of 'I'.

Table-3: 2X2 contingency table for head stroke of letter 'T' (total, N=100; df=1).

Hand	Left to right	Right to left
Left	35	15
Right	50	00

Null hypothesis (H_0) = formation of head stroke of letter 'T' is independent of hand of writer. Alternate hypothesis (Ha) = formation of head stroke of letter 'T' is dependent of hand of writer.

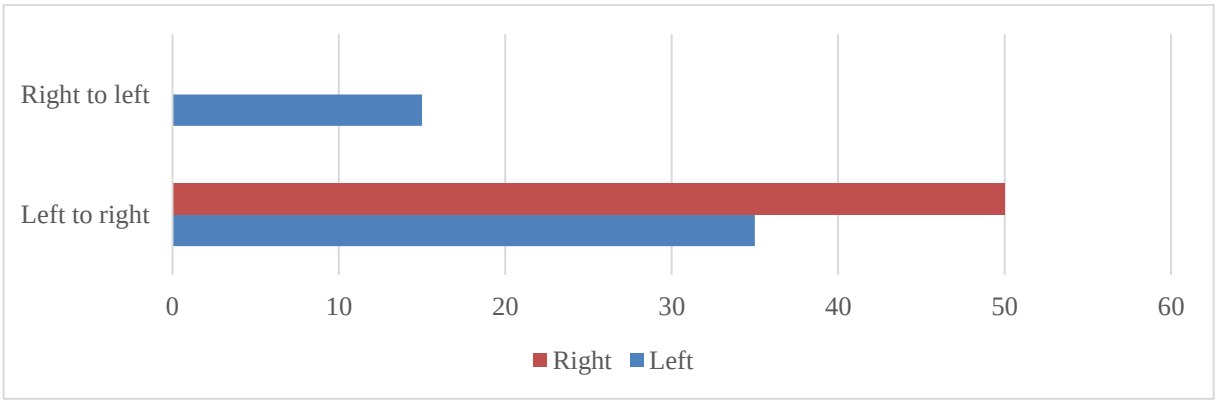

Figure-3: For head stroke of letter 'T'.

The chi square value for formation of head and base stroke of letter 'T' in all the handwriting specimens was 17.6471 ($p<0.05$; df =1; p= 0.000027). It was found to be significant at alpha = 0.05, dismissing the null hypothesis and adopting the alternate hypothesis for the formation of head stroke of letter 'T' is dependent of hand of writer.

The chi square value for formation of cutting stroke of letter 't' in all the handwriting specimens was 14.3095 ($p<0.05$; df =1; p= 0.000155). It was found to be significant at alpha = 0.05, dismissing the null hypothesis and adopting the alternate hypothesis for the formation of cutting stroke of letter 't' is dependent of hand of writer.

Table-4: 2X2 contingency table for cutting stroke of letter 't' (total, N=100; df=1).

Hand	Left to right	Right to left
Left	33	17
Right	49	1

Null hypothesis (H_0) = formation of cutting stroke of letter 't' is independent of hand of writer. Alternate hypothesis (Ha) = formation of cutting stroke of letter 't' is dependent of hand of writer.

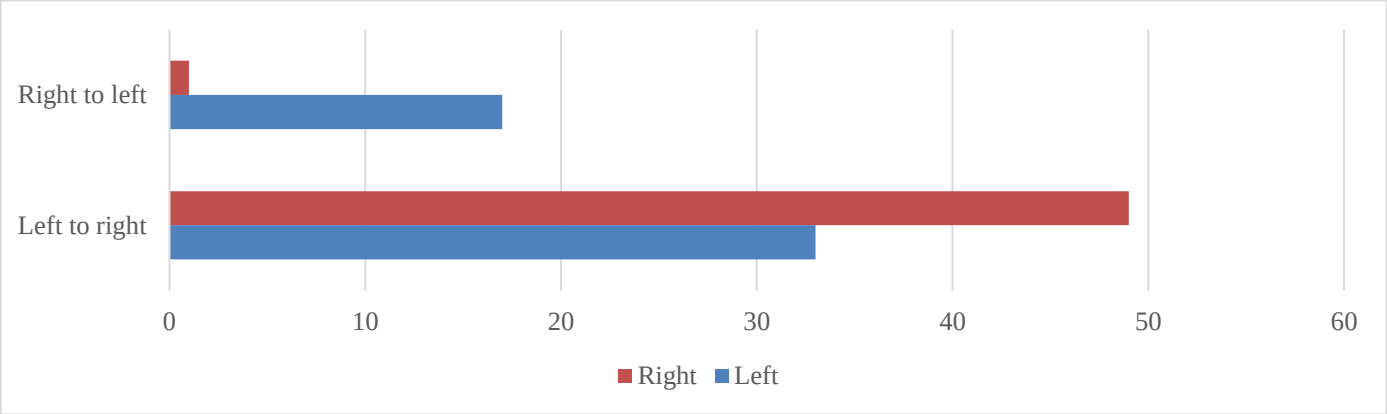

Figure-4: For cutting stroke of letter 't.

Table-5: 3x3 contingency table for vertical staff of letter 'h' (total, N=100; df=2).

Hand	Hook	Loop	Straight
Left	06	11	33
Right	08	13	29

Null hypothesis (H0) = formation of vertical staff of letter 'h' is independent of hand of writer, Alternate hypothesis (H_a) = formation of vertical staff of letter 'h' is dependent of hand of writer.

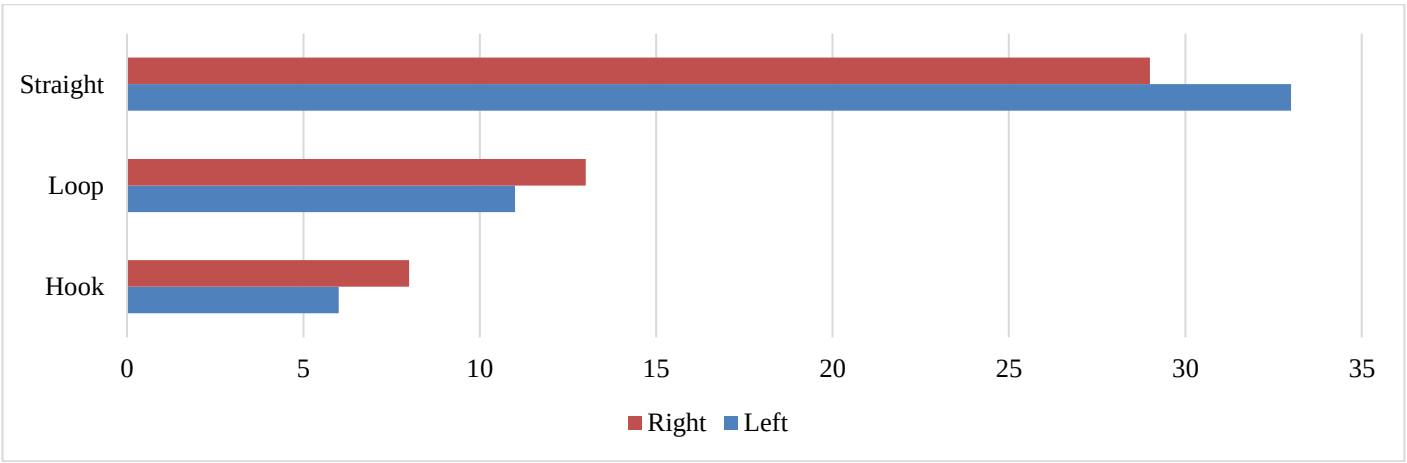

Figure-5: For vertical staff of letter 'h'.

The chi square value for formation of vertical staff of letter 'h' in all the handwriting specimens was 0.7104 ($p<0.05$; df =2; p=0.701017). It was found to be insignificant at alpha = 0.05, adopting the null hypothesis and dismissing the alternate hypothesis for the formation of vertical staff of letter 'h' is independent of hand of writer.

The chi square value for formation of vertical staff of letter 'b' in all the handwriting specimens was 0.9109 ($p<0.05$; df =3; p= 0.634172). It was found to be insignificant at alpha = 0.05, adopting the null hypothesis and dismissing the alternate hypothesis for the formation of vertical staff of letter 'b' is independent of hand of writer.

Table-6: 5x3 contingency table for vertical staff of letter 'b' (total, N=100; df=3).

Hand	Hook	Loop	Straight	Eyelet
Left	08	08	33	01
Right	05	08	37	00

Null hypothesis (H0) = formation of vertical staff of letter 'b' is independent of hand of writer, Alternate hypothesis (H_a) = formation of vertical staff of letter 'b' is dependent of hand of writer.

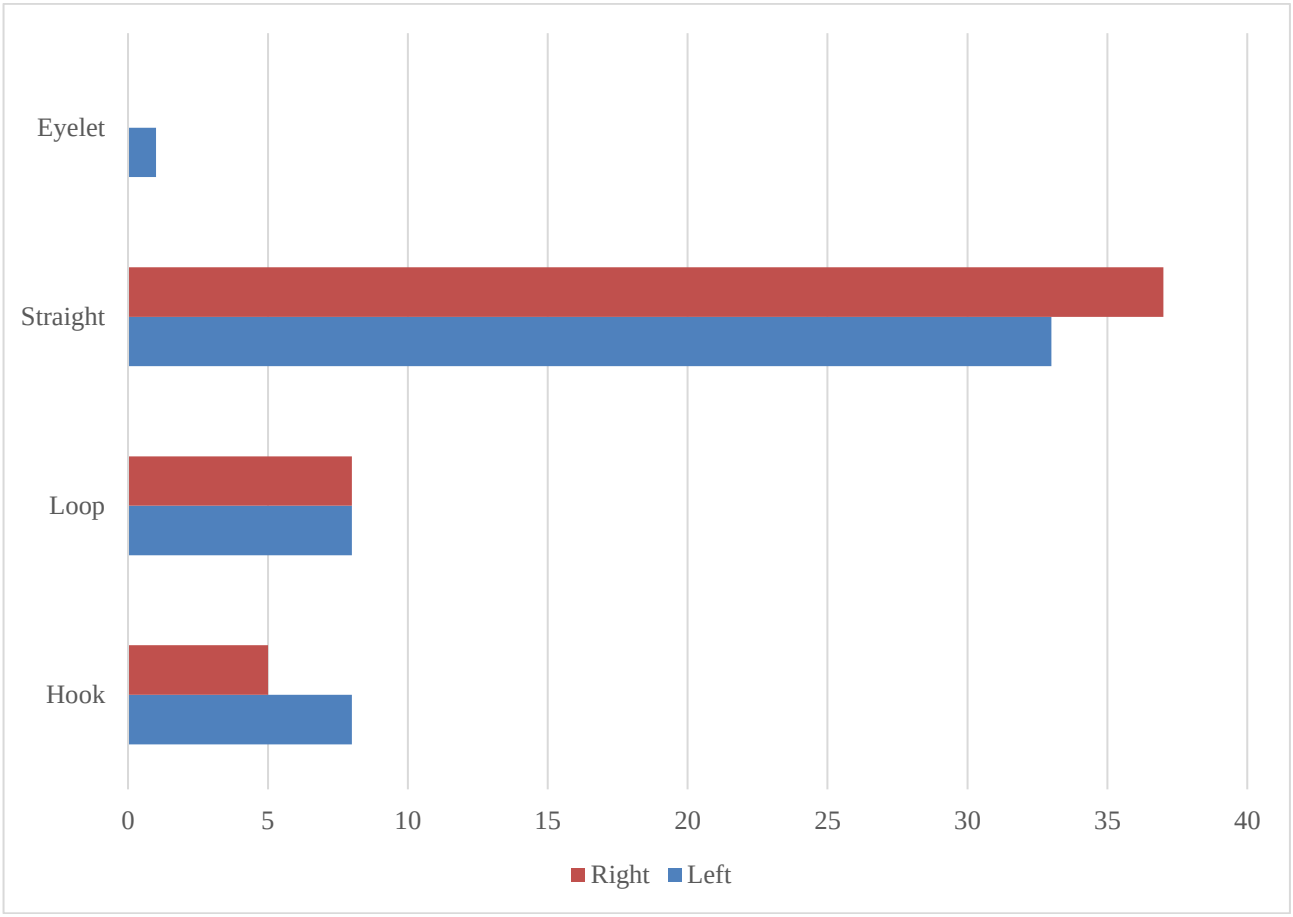

Figure-6: For vertical staff of letter 'b'.

Table-7: 2X2 contingency table for joining stroke of letter 'A' (total, N=100; df=1).

Hand	Left to right	Right to left
Left	31	19
Right	50	00

Null hypothesis (H_0) = formation of vertical staff of joining stroke of letter 'A' is independent of hand of writer, Alternate hypothesis (Ha) = formation of joining stroke of letter 'A' is dependent of hand of writer.

The chi square value for formation of vertical staff of letter 'A' in all the handwriting specimens was 23.4568 ($p<0.05$; df =1; p= <.00001). It was found to be significant at alpha = 0.05, dismissing the null hypothesis and adopting the alternate hypothesis for the formation joining stroke of letter 'A' is dependent of hand of writer.

The chi square value for formation of vertical staff of letter 'H' in all the handwriting specimens was 12.3596 ($p<0.05$; df =1; p= 0.00439). It was found to be significant at alpha = 0.05, dismissing the null hypothesis and adopting the alternate hypothesis for the joining stroke of letter 'H' is dependent of hand of writer.

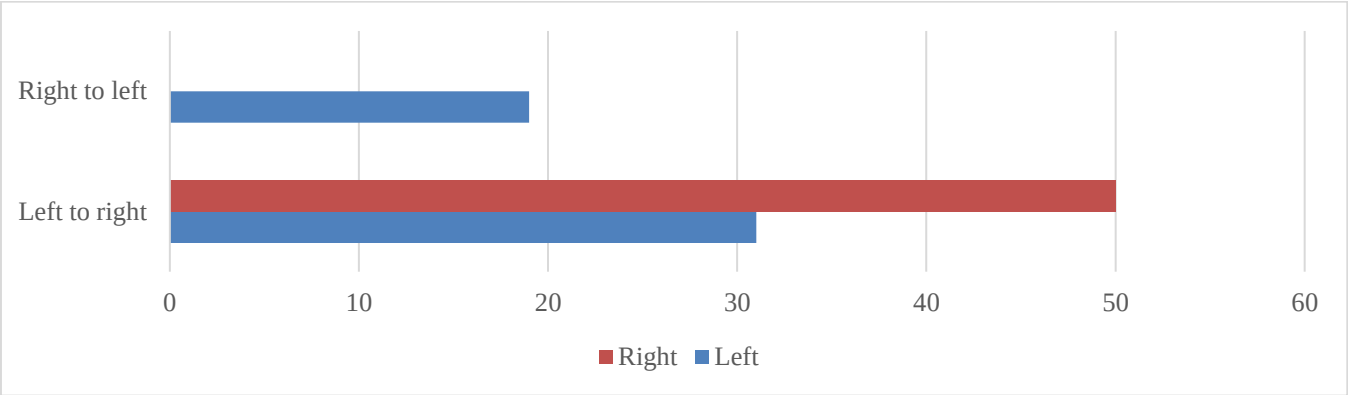

Figure-7: For joining stroke of letter 'A'.

Table-8: 3x3 contingency table for joining stroke of letter 'H' (total, N=100; df=1).

Hand	Left to right	Right to left
Left	39	11
Right	50	00

Null hypothesis (H_0) = formation of vertical staff of joining stroke of letter 'H' is independent of hand of writer, Alternate hypothesis (Ha) = formation of joining stroke of letter 'H' is dependent of hand of writer.

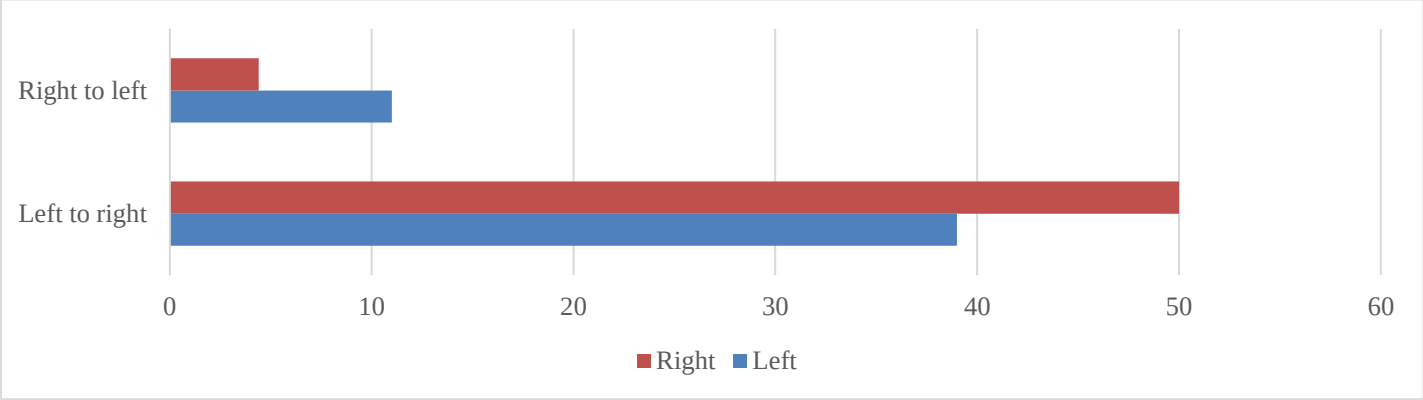

Figure-8: For joining stroke of letter 'H'.

Table-9: 3x3 contingency table for formation of slant of letter 'd' (total, N=100; df=2).

Hand	Forward	Vertical	backward
Left	27	19	04
Right	08	36	06

Null hypothesis (H_0) = formation of slant of letter 'd' is independent of hand of writer, Alternate hypothesis (Ha) = formation of slant of letter 'd' is dependent of hand of writer.

The chi square value for formation of slant of letter 'd' in all the handwriting specimen was 15.9688 ($p<0.05$; df=2; p= 0.000341). It was found to be significant at alpha = 0.05, dismissing the null hypothesis and adopting the alternate hypothesis for the formation of vertical staff of letter 'd' is dependent of hand of writer.

The chi square value for formation of slant of letter 't' in all the handwriting specimens was 18.6874 ($p<0.05$; df=2; p=0.000088). It was found to be significant at alpha = 0.05, dismissing the null hypothesis and adopting the alternate hypothesis for the formation of vertical staff of letter 't' is dependent of hand of writer.

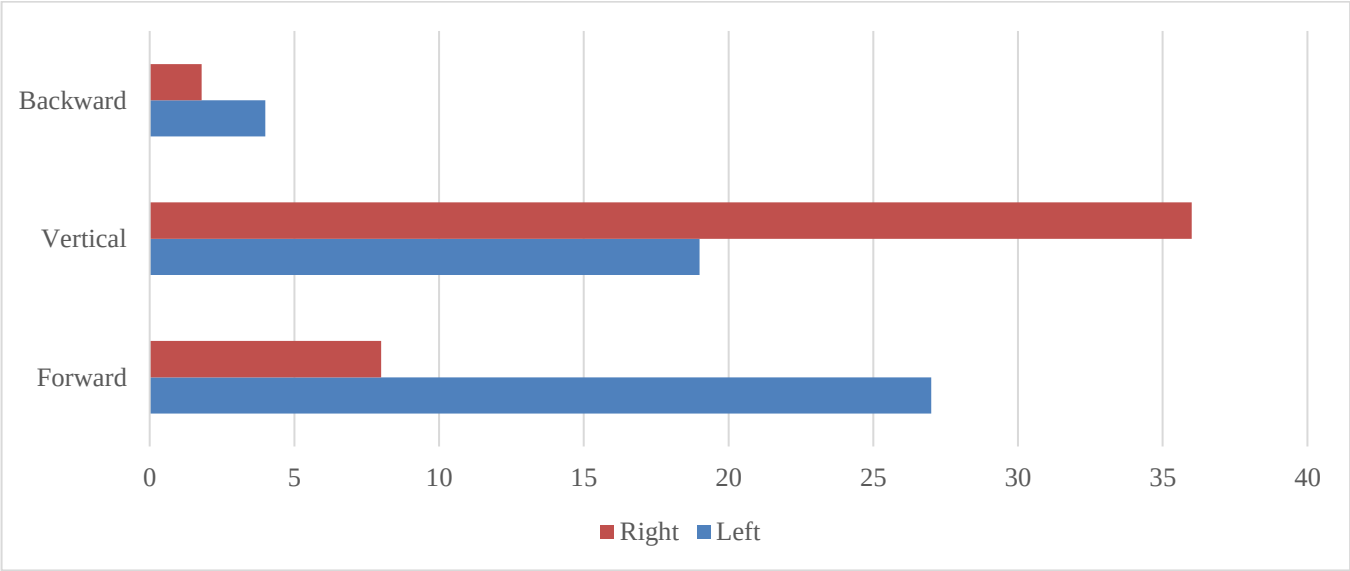

Figure-9: For formation of slant of letter 'd'.

Table-10: 3x3 contingency table for formation of slant of letter 't' (total, N=100; df=2).

Hand	Forward	Vertical	backward
Left	29	17	04
Right	09	38	03

Null hypothesis (H_0) = formation of slant of letter 't' is independent of hand of writer, Alternate hypothesis (Ha) = formation of slant of letter 't' is dependent of hand of writer.

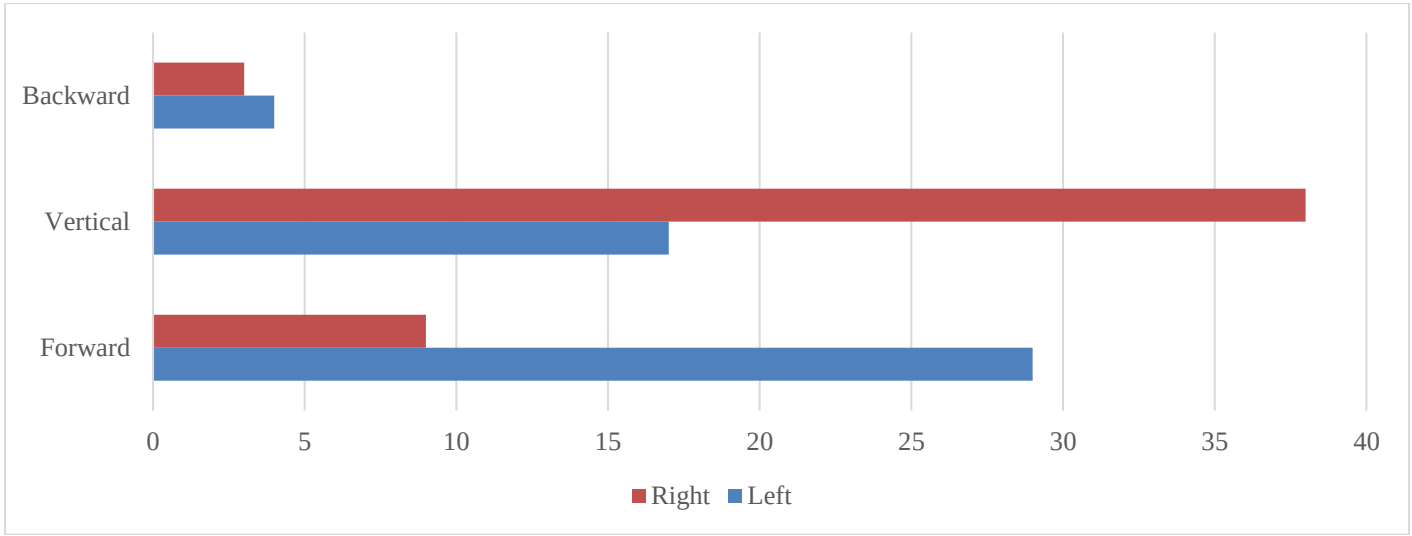

Figure-10: For formation of slant of letter 't'.

The chi square value for formation of slant of letter 'g' in all the handwriting specimens was 8.2952 ($p<0.05$; df=2; p= 0.015802). It was found to be significant at alpha = 0.05, dismissing the null hypothesis and adopting the alternate hypothesis for the formation of vertical staff of letter 'g' is dependent of hand of writer.

Table-11: 3x3 contingency table for formation of slant of letter 'g' (total, N=100; df=2).

Hand	Forward	Vertical	backward
Left	24	23	03
Right	11	37	02

Null hypothesis (H_0) = formation of slant of letter 'g' is independent of hand of writer, Alternate hypothesis (Ha) = formation of slant of letter 'g' is dependent of hand of writer.

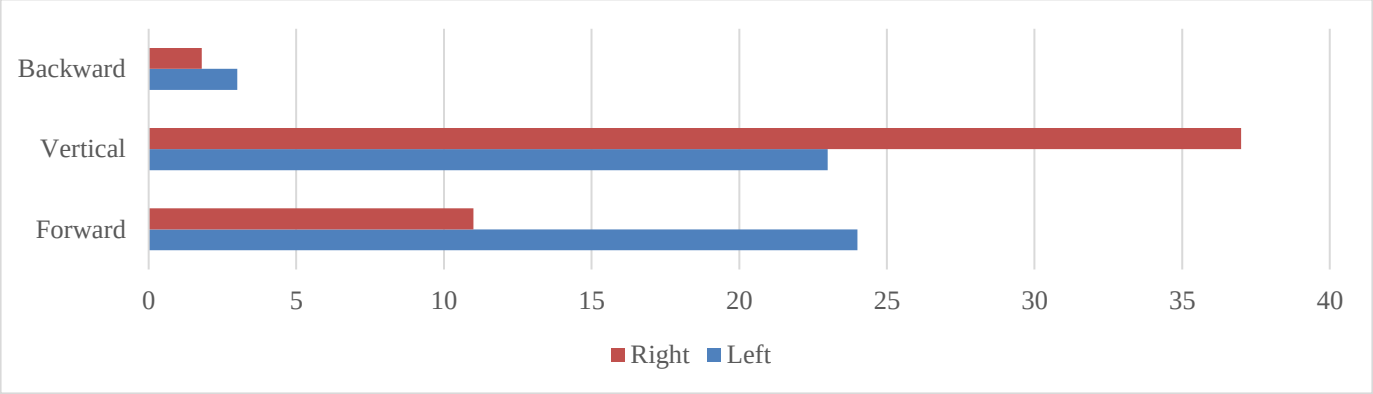

Figure-11: For formation of slant of letter 'g'.

Table-12: 3x3 contingency table for formation of slant of letter 'y' (total, N=100; df=2).

Hand	Forward	Vertical	backward
Left	25	22	03
Right	10	38	02

Null hypothesis (H_0) = formation of slant of letter 'y' is independent of hand of writer, Alternate hypothesis (Ha) = formation of slant of letter 'y' is dependent of hand of writer.

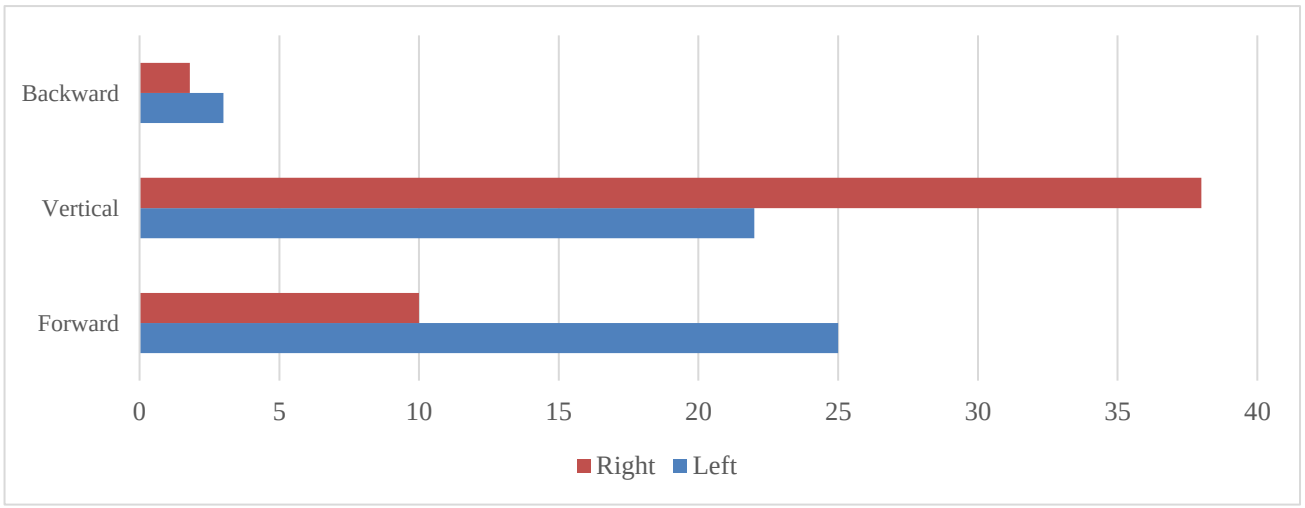

Figure-12: For formation of slant of letter 'y'.

The chi square value for formation of slant of letter 'y' in all the handwriting specimens was 25.9846 ($p<0.05$; df=2; p=< 00001). It was found to be significant at alpha = 0.05, dismissing the null hypothesis and adopting the alternate hypothesis for the formation of vertical staff of letter 'y' is dependent of hand of writer.

The chi square value for formation of head stroke of letter 'E' in all the handwriting specimens was 18.3156 ($p<0.05$; df =1; p= 0.000019). It was found to be significant at alpha = 0.05, dismissing the null hypothesis and adopting the alternate hypothesis for the formation of head and base stroke of letter E is dependent of hand of writer.

Table-13: 2x2 contingency table for head stroke of letter 'E' (total, N=100; df=1).

Hand	Left to right	Right to left
Left	27	23
Right	46	04

Null hypothesis (H_0) = formation of head stroke of letter E is independent of hand of writer, Alternate hypothesis (Ha) = formation of head stroke of letter E is dependent of hand of writer.

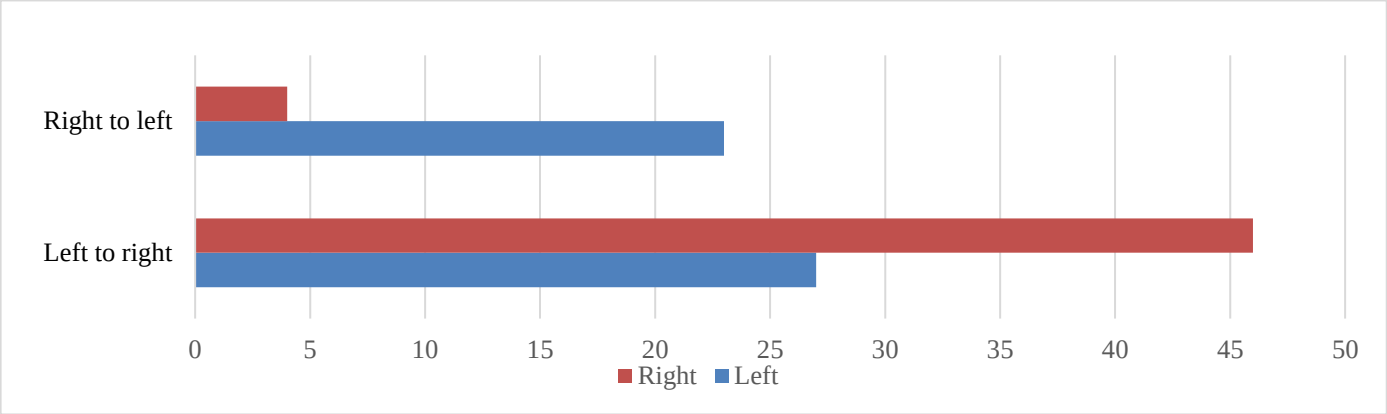

Figure-13: For head stroke of letter 'E'.

Table-14: 2X2 contingency table for head stroke of letter 'F' (total, N=100; df=1)

Hand	Left to right	Right to left
Left	33	17
Right	50	00

Null hypothesis (H_0) = formation of head stroke of letter F is independent of hand of writer, Alternate hypothesis (Ha) = formation of head stroke of letter F is dependent of hand of writer.

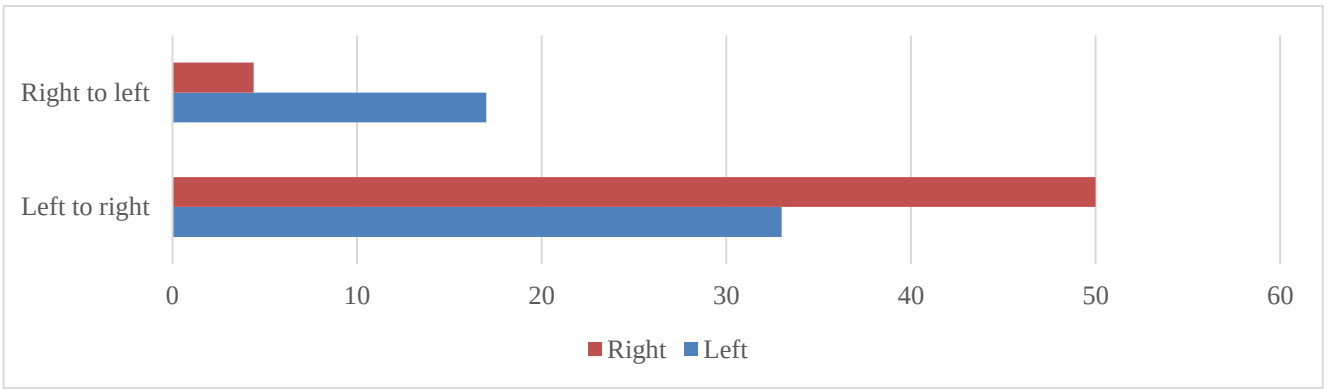

Figure-14: For head stroke of letter 'F'.

Table-15: 2x2 contingency table for direction of making letter 'O' (total, N=100; df=1).

Hand	Left to right	Right to left
Left	40	10
Right	50	00

Null hypothesis (H_0) = formation of direction of making letter 'O' is independent of hand of writer, Alternate hypothesis (Ha) = formation of direction of making letter 'O' dependent of hand of writer.

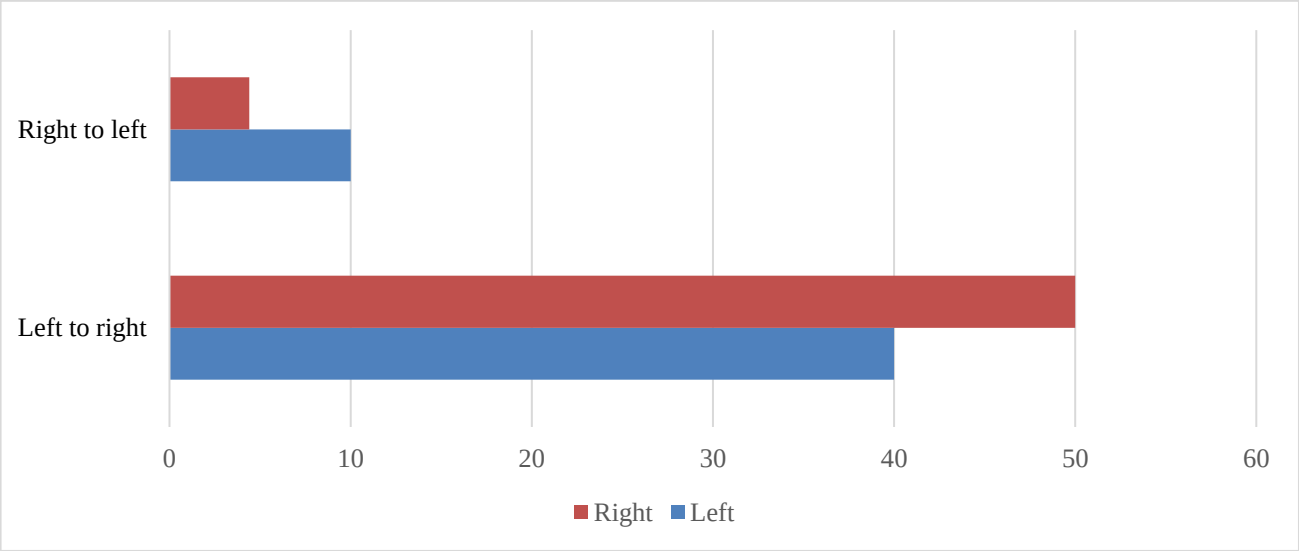

Figure-15: For direction of making letter 'O'.

The chi square value for formation of head stroke of letter 'F' in all the handwriting specimens was 20.4819 ($p<0.05$; df =1; p= <.00001). It was found to be significant at alpha = 0.05,dismissing the null hypothesis and adopting the alternate hypothesis for the formation of head and base stroke of letter F is dependent of hand of writer.

The chi square value for formation of head stroke of letter 'O' in all the handwriting specimens was 11.1111 ($p<0.05$; df =1; p= 0.000858). It was found to be significant at alpha = 0.05, dismissing the null hypothesis and adopting the alternate hypothesis for the formation of head and base stroke of letter O is dependent of hand of writer.

The results are provided in the above observation tables which emphasize on the dissimilarities between the left-handed author and right-handed author based on handwriting characteristics. It shows that left-handed authors tend to make strokes of the letter starting from right side and ending on left, the slope of letters has an inclination in the forward direction. Whereas, right-handed authors tend to form strokes of the letters from left side to right side direction and the slope of letters mostly remained vertical or in the forward direction. These data of samples were checked by Statistical- Analysis. Significant chi-square value and p-value supported the hypothesis.

Conclusion

According to the and above given tables, it has been established that left-handed authors were more inclined to make strokes in right-to-left direction and the slant of letters had an ascent in forward direction for most of the alphabets whereas right-handed writer made stokes in starting from left side and ending on right side and the slant was mostly vertical in most of the alphabets selected for study. By further analysis through Chi square test we found out the significance for various characteristics features of handwriting like formation of 'i'-dot, head stoke of letter 'T', cutting stroke of letter 't', Joining stroke of letter 'A'&'H', Slant of letter 'd', 'g', 't', 'y', Head stoke of letter 'E'&'F' and direction of making letter 'o' are dependent on the hand of the writer. And all the above characteristic features are significantly helpful in finding out the handedness of the writer by examining the handwriting samples. Thus, we can eliminate various suspects in the questioned document cases with the help above examination.

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