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RESEARCH ARTICLE

Handedness and Gender Determination by Handwriting Examination

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Abstract

The purpose of this study is to find out if there are any differences between sinistral and dextral individuals as well as differences in gender based on their handwriting characteristics which will help in identifying the author in case of anonymous letters or any other document whose author is unknown. This study was conducted on 25 left-handed males, 25 left-handed females, 25 right-handed males and 25 right-handed females. A control passage was dictated to the subjects and they had to write it twice, in their own handwriting, on the two blank sheets provided. The characteristics of the handwriting were analyzed. According to the findings of this study, the horizontal strokes of the numbers “1”, “5”, “7”; the letters “A”, “E”, “F”, “H”, “I”, “J”, “T”, “f”, “t” and the Hyphen (-) executed from the right to the left direction and the circular strokes of the numbers “9”, “0” and the letters “O”, “Q” and “o” executed in the clockwise direction indicate that the character has most likely been executed by a left-handed individual while the horizontal strokes executed from the left to the right direction and the circular strokes executed in the anti-clockwise direction indicate that the character has most likely been executed by a right-handed individual.

Keywords: Questioned Document, Handwriting, Handedness, Gender, Forensics

Introduction

The handwriting of an individual is his or her distinctive style of writing. The handwriting of an individual develops due to habit and learning but eventually gets personalized (Muhammad et al, 2011). Handwriting is executed with the aid of writing materials and the muscles and nerves present in the hands. (Saran et al, 2013; Uthaicham et al, 2010) The pen grip, hand-eye coordination and flexibility of the fingers and wrist contribute to the development of handwriting (Koppenhaver, 2010). No two handwriting samples authored by the same

writer can be exactly the same in every aspect. These deviations found in the handwriting of an individual are called as natural variations (Saferstein, 2014).

Sinistrality and Dextrality, when an individual prefers using the left side of his body as the dominant side to do manual tasks it is called as sinistrality and if an individual prefers using the right side it is called as dextrality. The preference for using a particular hand is not consistent for all tasks in some individuals. From a range of tasks, handwriting has proved to be the most consistent indicator of

handedness. Thus if a person writes with a particular hand he is more likely to use that hand for other tasks as well. According to studies, 11% of the general

However, it is not possible to accurately determine the handedness of a person. An examiner can only say that a particular handwriting most probably belongs to a left or right-handed individual (Skelton, 2011).

Left-handed individuals are found to make the horizontal stroke across the letters t, f, A, I, E, F from right to left direction and right-handed individuals make the stroke from left to right direction. The slope of the letters t, l, d, f, g, and y of left-handed individuals are found to be in the backward direction while the slope of the letters of right-handed individuals are found to be in the forward direction (Saran, 2013). Left-handed individuals tend to execute a heavy upstroke and use the left edge of the ball point pen (Uthaicham et al, 2010). The stroke across t from right to left, the dot on i dragged towards the left, absence of ending strokes or dragging the ending strokes slightly towards the left in certain letters, triangular or v-shaped lower parts of lowercase g and y are some of the traits that show left-handed writing (Joseph, 2004). Right to left horizontal strokes of characters A, J, T, F, G, E, H, t and 5 and clockwise movement of the circular portion of O, Q, o, q, g and 9 are features that are more likely to appear in the handwriting of a left-handed individual (Yinon, 1991). Right-handed individuals tend to write with a greater forward slope compared to left handed individuals but the results are not statistically significant (Huber et al, 1999)

Right handed subjects show more variation in letters/forms/connectives, originality and improving school form than left handed individuals. Differences between the handwriting of males and females are found to be more reliable than differences based on handedness. (David et al, 1982). There is no correlation between handedness or sex of a writer and the height of the characters in the writing (Huber et al, 1999). The crossing of t from the right to the left direction can be identified by the tapering end of the cross-bar on the left side and it is a characteristic of left-handed writing (Lafone, 2014). There is no correlation between the writing performance of left and right-handed individuals. Slant, speed,

adult population is found to be sinistral and a higher number of males are sinistral compared to females (Huber et al, 1999).

alignment, size, proportions and skill are not very reliable features of handedness (Huber et al, 1999).

This study was done to determine the differences between the handwriting of left-handed (Sinistral) and right-handed (Dextral) individuals based on the characteristics of handwriting and also to determine the differences between left-handed females and left-handed males as well as right-handed females and right-handed males based on the characteristics of handwriting.

- 1) The horizontal strokes of the characters “l”, “5”, “7”, “A”, “E”, “F”, “H”, “I”, “J”, “T”, “f”, “t” and Hyphen (-) executed from right to the left direction indicate that the character has been executed by a left-handed individual while the horizontal strokes executed from the left to the right direction indicate that the character has been executed by a right-handed individual. (Based on the studies conducted on the direction of cross-bars.)
- 2) The circular strokes of “9”, “0”, “O”, “Q” and “o” executed in the clockwise direction indicate that the character has been executed by a left-handed individual while the strokes executed in the anti-clockwise direction indicate that the character has been executed by a right-handed individual. (Based on the studies conducted on the direction of circular strokes.)
- 3) The circular strokes of the “circle on i”, “circle on j”, “colon (:)", “full-stop (.)”, “circle of exclamation mark (!)", “circle of question mark (?)” and “semi-colon (;)” executed in the clockwise direction indicate that the character has been executed by a left-handed individual while the circular strokes executed in the anti-clockwise direction indicate that the character has been executed by a right-handed individual. (Based on the studies conducted on the direction of circular strokes.)
- 4) The leftward drag of the “dot of i”, “dot of j”, “colon (:)", “full-stop (.)”, “dot of exclamation mark (!)", “dot of question mark (?)” and “semi-colon (;)” indicates that the character has been executed by a left-handed

individual while the rightward drag indicates that the character has been executed by a right-handed individual (Joseph, 2004).

- 5) A V-shaped ending of the down strokes in the characters J, g, j and y indicates that the character has been executed by a left-handed individual (Joseph, 2004).
- 6) The absence of a connecting stroke between the horizontal stroke of the first character and the initial stroke of the next character in the character combinations of “th”, “ti”, “AM” “Th”, “To”, “to”, “Ar”, “fo”, “ta”, “An”, “Ea”, “Fr”, “Fo”, “te”, “tr” and “He” indicates that the character combination has been executed by a left-handed individual while the presence of a connecting stroke indicates that the character combination has been executed by a right-handed individual. (Based on the studies conducted on the direction of cross-bars.)
- 7) More shading of upstrokes due to heavy pen-point pressure in case of ball-point pen, (Ordway, 1957) than down strokes of the loops of cursive “G”, cursive “J”, cursive “Y” and “the overall shading” of the handwriting of the individual indicates that the character has been executed by a left-handed individual. (Based on the study by Uthaichaem et al, 2010.)

[The pen lifts (if any) in the numbers “1”, “2”, “3”, “4”, “5” and “7”; the eyelets (if any) formed in “2” and “3”; the angularity of the initial stroke of “3”; the initial hook (if present) of the numbers “1” and “7”; the ending stroke of the letter “G”, the direction of the formation of the number “8”, the absence or presence of a connecting stroke between consecutive zeroes “00” and the formation of “&” were also examined for the purpose of this study.]

Materials and Methods

This study was conducted on 25 left-handed males, 25 left-handed females, 25 right-handed males and 25 right-handed females. The samples were all collected from South India. The method used to collect the sample was snowball technique. The materials used for collecting the handwriting samples included the sample collection and subject details sheets, Blue Cello Maxriter ballpoint pens

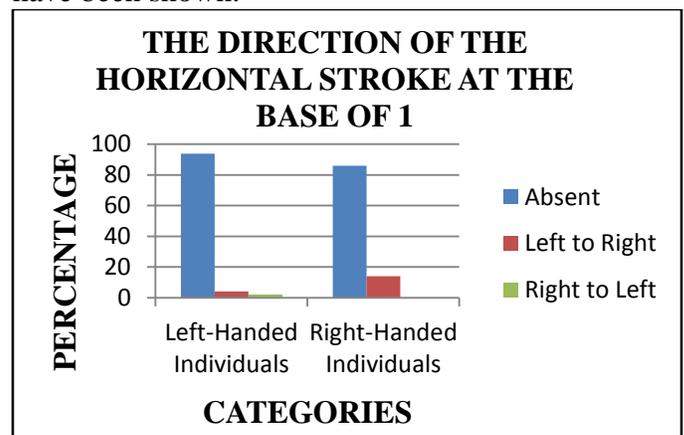
and a control passage with all the required handwriting characteristics for the purpose of this study. The materials used for analysis included a magnifying lens and a Stereo Microscope.

The consent of the subject was taken. The subject was seated comfortably. Two sample collection sheets were provided to the subject in order to rule out natural variations along with a blue Cello Maxriter ballpoint pen. The subject was asked to fill in his/her personal details. The control passage was dictated to the subject so that the subject writes in his or her own handwriting as well as in order to maintain the standard protocol that is followed while collecting exemplars. The subject wrote down the passage on the sheet with his/her dominant hand. The handwriting sample of the subject was collected on the second sheet in the same manner.

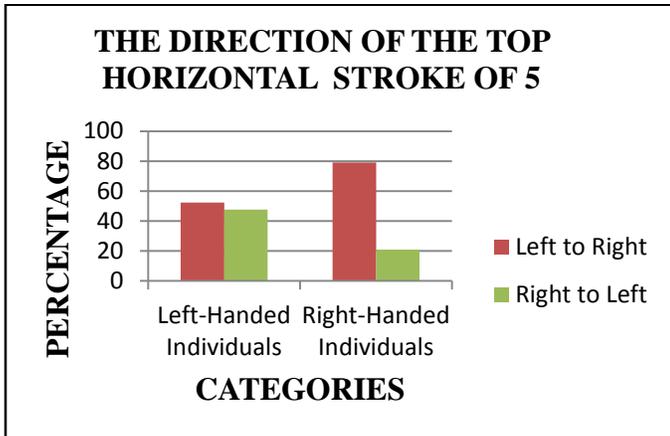
The characteristics of handwriting were examined using a magnifying lens. A stereo microscope was used to examine the characteristics that could not be clearly visualized using the magnifying lens. Any characteristics executed by the same individual which showed differences due to natural variations, or characters in which the feature to be examined was absent or the characteristics which could not be determined using the method based on the study by Mikels to determine the direction of the horizontal strokes, were eliminated.

Results

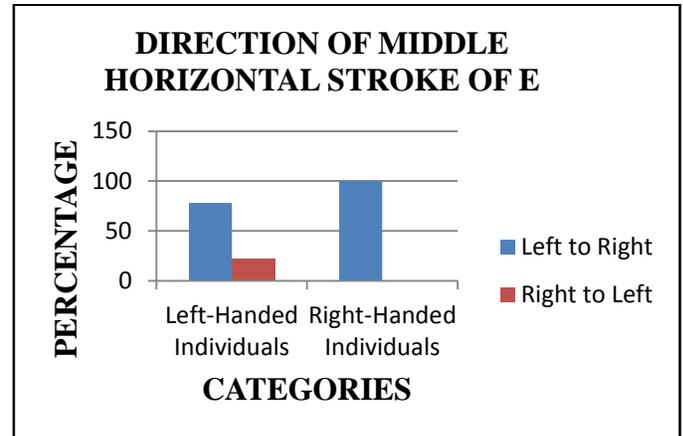
The graphs of the most significant results have been shown.



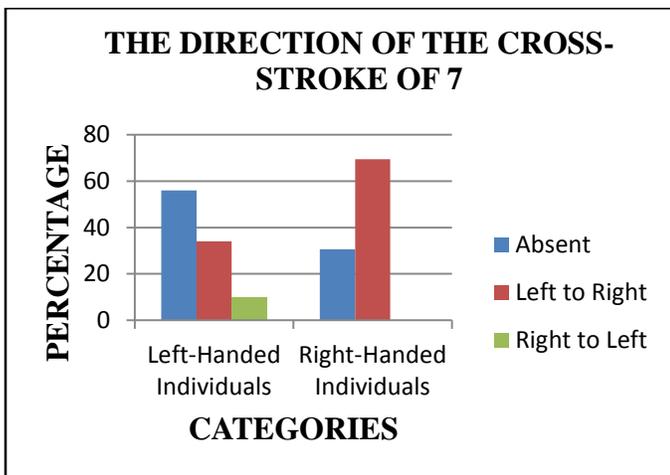
Graph 1: Showing the comparison of “The direction of the horizontal stroke at the base of 1” between left-handed individuals and right-handed individuals in the sample population.



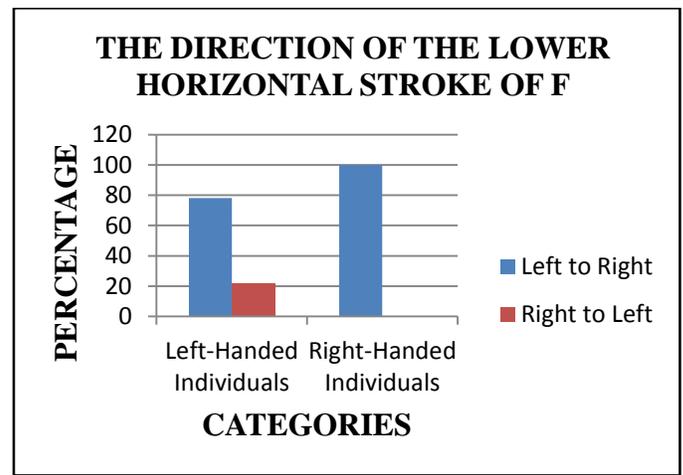
Graph 2: Showing the comparison of “The direction of the top horizontal stroke of 5” between left-handed individuals and right-handed individuals in the sample population.



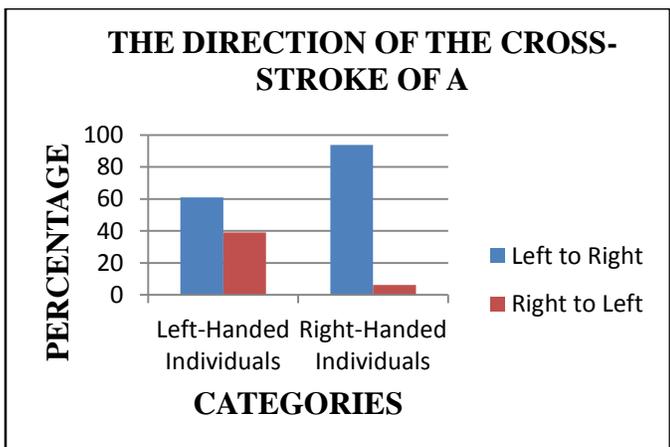
Graph 5: Showing the comparison of “The direction of the middle horizontal stroke of E” between left-handed individuals and right-handed individuals in the sample population.



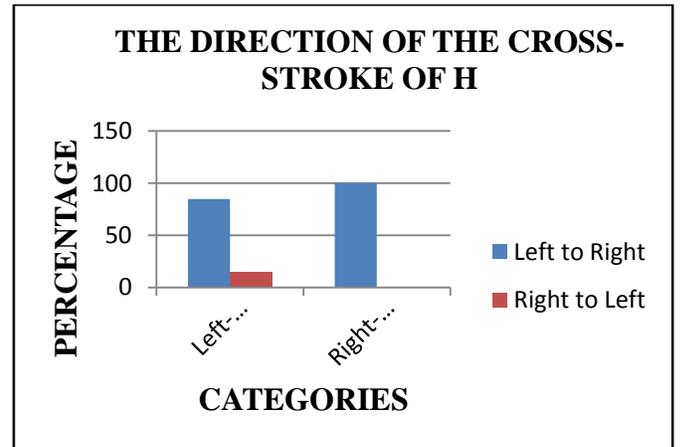
Graph 3: Showing the comparison of “The direction of the cross-stroke of 7” between left-handed individuals and right-handed individuals in the sample population.



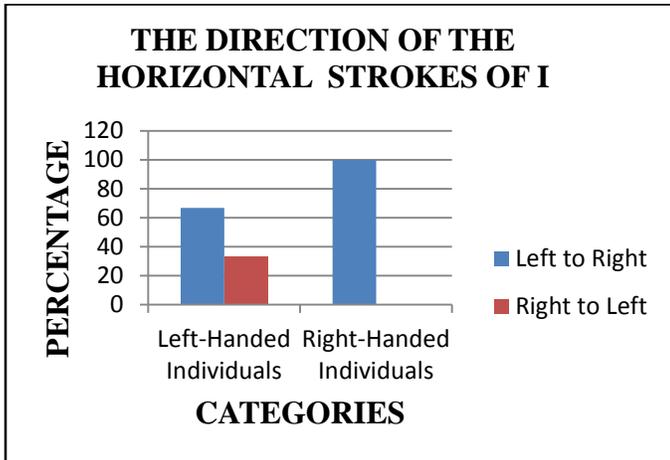
Graph 6: Showing the comparison of “The direction of the lower horizontal stroke of F” between left-handed individuals and right-handed individuals in the sample population.



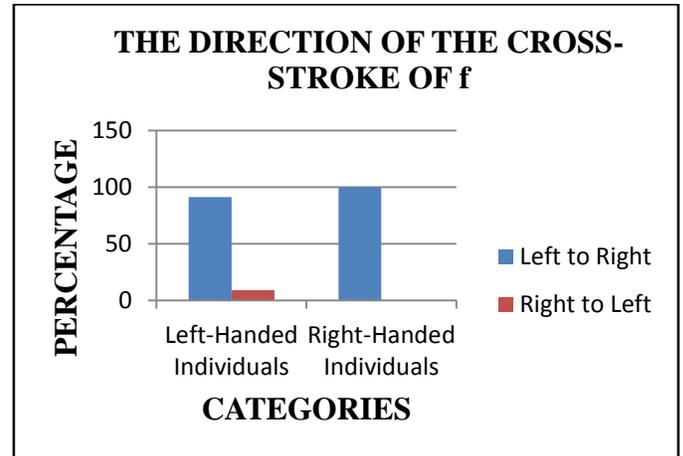
Graph 4: Showing the comparison of “The direction of the cross-stroke of A” between left-handed individuals and right-handed individuals in the sample population.



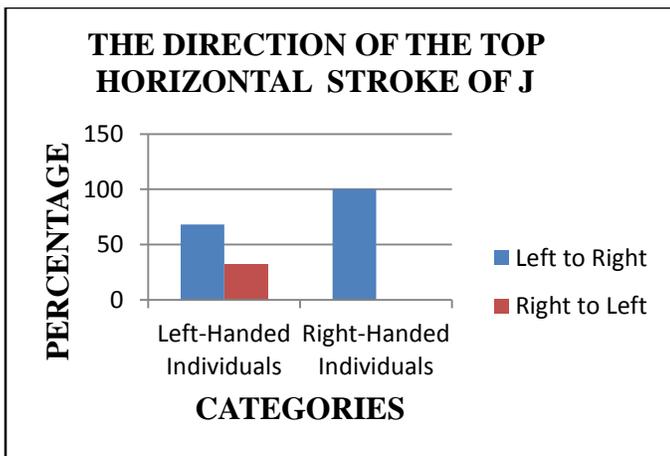
Graph 7: Showing the comparison of “The direction of the cross-stroke of H” between left-handed individuals and right-handed individuals in the sample population.



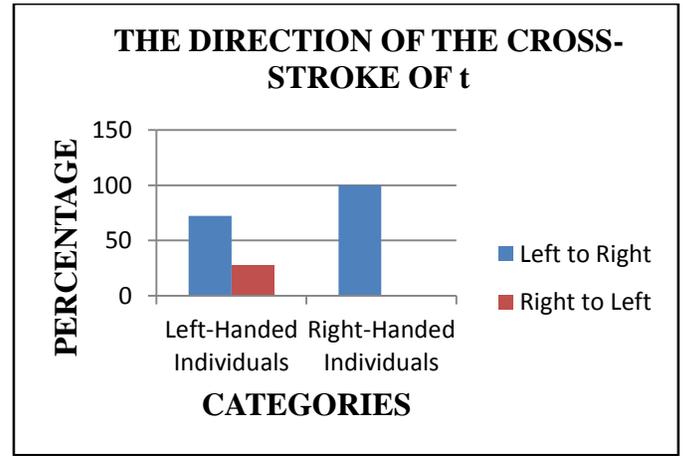
Graph 8: Showing the comparison of “The direction of the horizontal strokes of I” between left-handed individuals and right-handed individuals in the sample population.



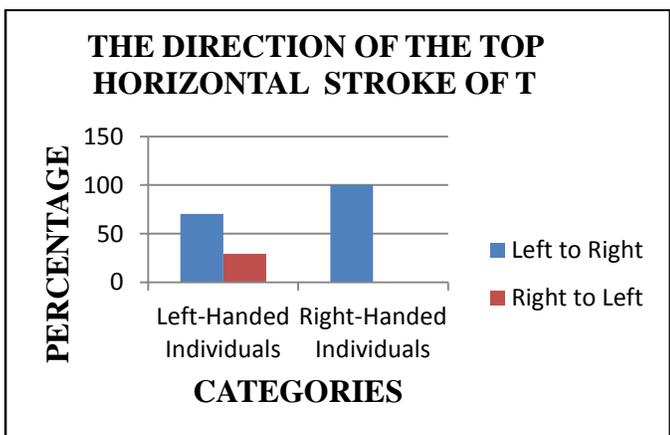
Graph 11: Showing the comparison of “The direction of the cross-stroke of f” between left-handed individuals and right-handed individuals in the sample population.



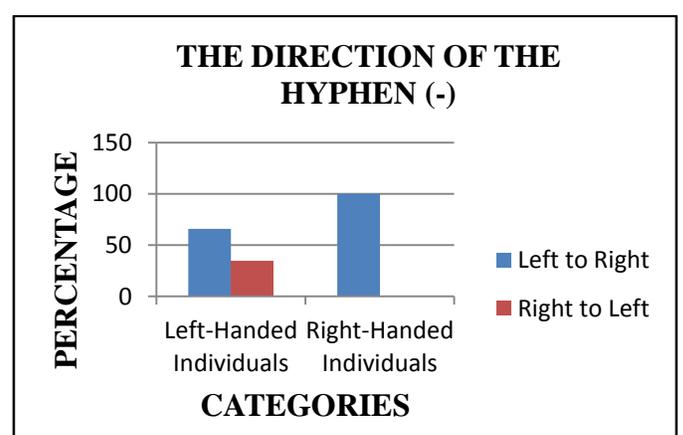
Graph 9: Showing the comparison of “The direction of the top horizontal stroke of J” between left-handed individuals and right-handed individuals in the sample population.



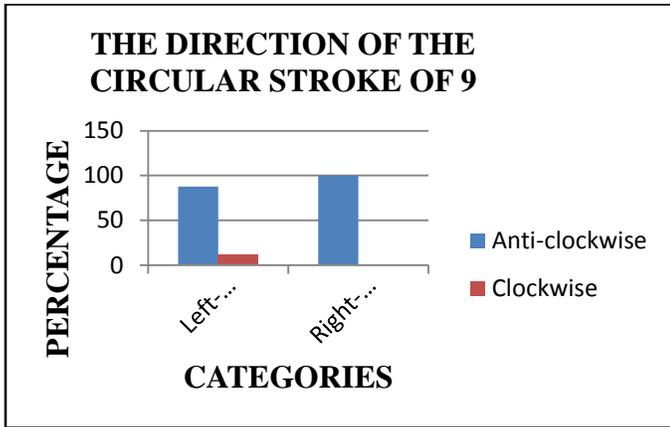
Graph 12: Showing the comparison of “The direction of the cross-stroke of t” between left-handed individuals and right-handed individuals in the sample population.



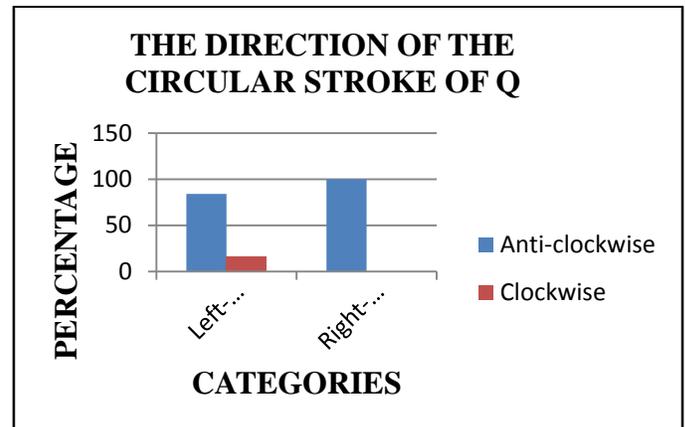
Graph 10: Showing the comparison of “The direction of the top horizontal stroke of T” between left-handed individuals and right-handed individuals in the sample population.



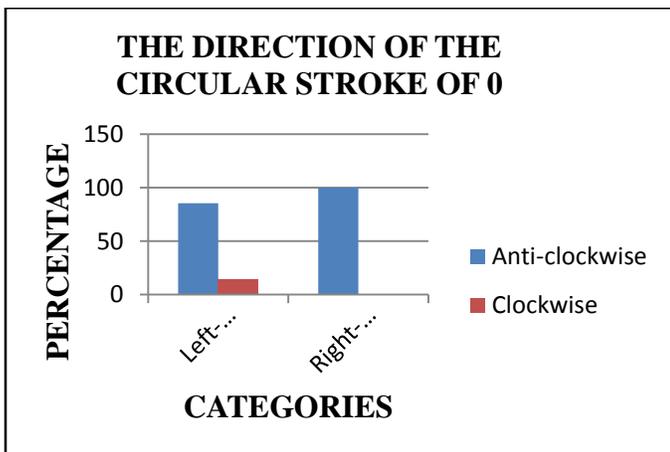
Graph 13: Showing the comparison of “The direction of the hyphen (-)” between left-handed individuals and right-handed individuals in the sample population.



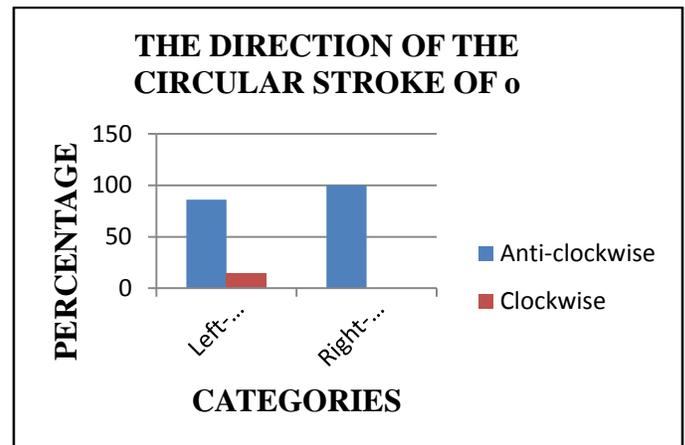
Graph 14: Showing the comparison of “The direction of the circular stroke of 9” between left-handed individuals and right-handed individuals in the sample population.



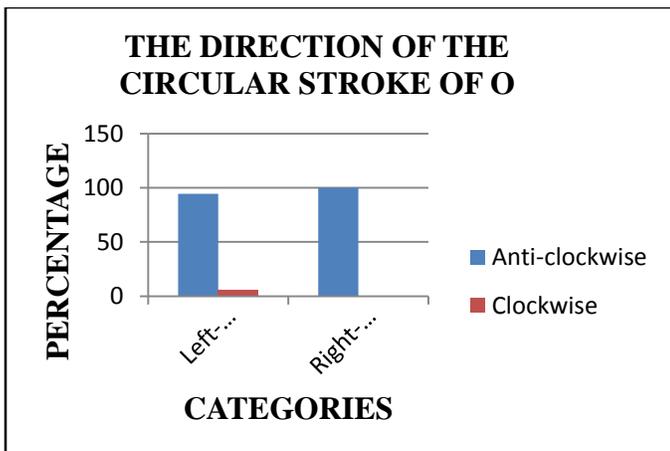
Graph 17: Showing the comparison of “The direction of the circular stroke of Q” between left-handed individuals and right-handed individuals in the sample population.



Graph 15: Showing the comparison of “The direction of the circular stroke of 0” between left-handed individuals and right-handed individuals in the sample population.



Graph 18: Showing the comparison of “The direction of the circular stroke of o” between left-handed individuals and right-handed individuals in the sample population.



Graph 16: Showing the comparison of “The direction of the circular stroke of O” between left-handed individuals and right-handed individuals in the sample population.

Discussion

Based on previous research papers, the horizontal strokes of characters are executed from the right to the left direction by a higher percentage of left-handed individuals while the horizontal strokes are executed from the left to the right direction by a higher percentage of right-handed individuals. In this study, left-handed individuals have a higher preference compared to right-handed individuals for executing the top horizontal stroke of the number “5” and the cross-stroke of the letter “A” from the right to the left direction. The horizontal stroke at the base of the number “1”, the cross-stroke of number “7”, the middle horizontal stroke of “E”, the lower horizontal stroke of “F”, the cross-stroke of “H”, the horizontal strokes of “I”, the top

horizontal stroke of “J”, the top horizontal stroke of “T”, the cross-stroke of “f”, the cross-stroke of “t” and the hyphen (-) are executed from the right to the left direction only by left-handed individuals. The horizontal strokes are found to be executed from the left to the right direction by a higher percentage of right-handed individuals compared to left-handed individuals. The results are found to be significant.

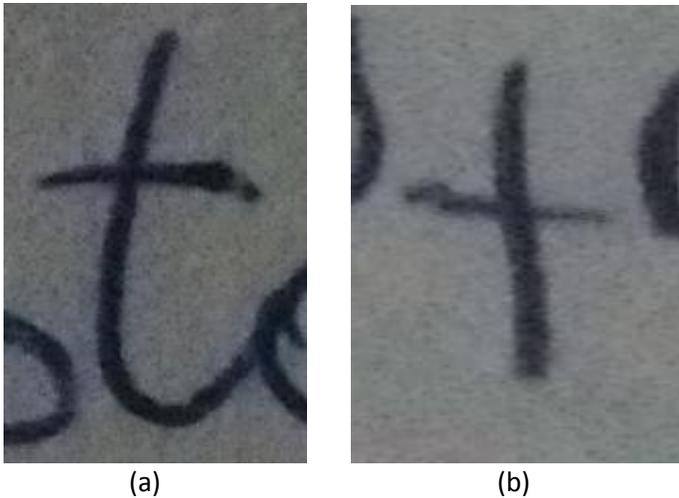


Figure 1: (a) Cross-Stroke of “t” executed from the right to the left direction by a higher percentage of left-handed individuals. (b) Cross-Stroke of “t” executed from the left to the right direction by a higher percentage of right-handed individuals.

Thus, the horizontal strokes of the numbers “1”, “5” and “7”; the letters “A”, “E”, “F”, “H”, “I”, “J”, “T”, “f”, “t” and the Hyphen (-) executed from the right to the left direction, indicate that the character has most likely been executed by a left-handed individual while the horizontal strokes executed from the left to the right direction indicate that the character has most likely been executed by a right-handed individual.

Based on previous research papers, the circular strokes of characters are executed in the clockwise direction by a higher percentage of left-handed individuals while the circular strokes of characters are executed in the anti-clockwise direction by a higher percentage of right-handed individuals. In this study, the circular strokes of the numbers “9” and “0” and the letters “O”, “Q” and “o” are found to be executed in the clockwise direction only by left-handed individuals while right-handed

individuals have a higher preference compared to left-handed individuals for executing the circular strokes in the anti-clockwise direction. The results are found to be significant.

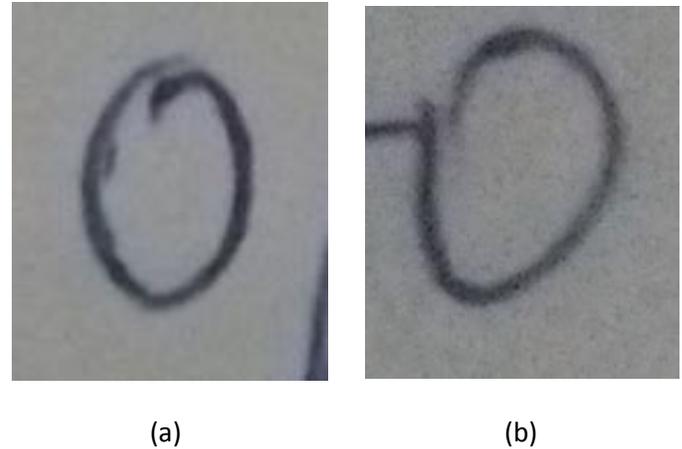


Figure 2: (a) “o” executed in the clockwise direction by a higher percentage of left-handed individuals. (b) “o” executed in the anti-clockwise direction by a higher percentage of right-handed individuals.

Thus, the circular strokes of the numbers “0” and “9” and the letters “O”, “Q” and “o” executed in the clockwise direction indicate that the character has most likely been executed by a left-handed individual while the circular strokes executed in the anti-clockwise direction indicate that the character has most likely been executed by a right-handed individual.

The V-shaped ending of the down stroke of the letters “J”, “g”, “j” and “y”; the shading of the loops of cursive “G”, cursive “J”, cursive “Y” and “the overall shading” of the handwriting of the individual; the connecting stroke between the horizontal stroke of the first character and the initial stroke of the next character in the character combinations of “th”, “ti”, “AM” “00” “Th”, “To”, “to”, “Ar”, “fo”, “ta”, “An”, “Ea”, “Fr”, “Fo”, “te”, “tr” and “He”; the pen lifts in the numbers “1”, “2”, “3”, “4”, “5” and “7”; the eyelets formed in “2” and “3”; the angularity of the initial stroke of “3”; the drag of the dot on the letter “i”, the dot on the letter “j”, full-stop (.), semi-colon (;), colon (:), the dot of question mark (?) and the dot of exclamation mark (!); the direction of the circular stroke on the letter “i”, on the letter “j”, full-stop (.), semi-colon (;), colon (:), question mark (?) and exclamation mark

(!); the initial angular stroke of the numbers “1” and “7”; the ending stroke of the letter “G”, the direction of the formation of the number “8” and the formation of “&” are not found to be very reliable in indicating the handedness of the individual. None of the characteristics are found to be reliable in indicating the gender of the individual.

Further research should be conducted on these characteristics to check for consistency with the results of this study by taking a larger sample size. Characteristics of handwriting other than the characteristics used in this study can be examined to determine if there are differences between the handwriting of left and right-handed individuals. The characteristics that determine sinistral writing can be further examined in disguised writings of left-handed individuals to determine if these characteristics are disguised or not while using the dominant left hand and while using the unaccustomed hand. The differences in handwriting based on hand position i.e. IHP (Inverted Hand Position) and NHP (Normal Hand Position) in left-handed as well as right-handed individuals can be examined.

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