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Gender determination and inheritance of handwriting features: A Forensic Approach

Bansal H[1, a], Mishra SD[3*], Kapoor N[1], Badiye A[2]

[1]Assistant Professor, [2]Head & Assistant Professor, Department of Forensic Science, Govt. Institute of Forensic Science, Nagpur, Maharashtra, India.
[a]Research Scholar, SVVV, Indore, Madhya Pradesh, India
[3]Assistant Professor, Shri Vaishnav Institute of Forensic Science, SVVV, Indore, Madhya Pradesh, India.
*Corresponding author Email: swatidmishra01@gmail.com

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ABSTRACT

Handwriting is a unique characteristic of a person. As the use of documents has increased over the time, the misuse and crime related to documents has increased immensely. One of the important aspects of handwriting that helps in identification of an individual are the natural variations. Identification of gender helps in reducing the suspect pool in a significant manner. On the other side, in disputes involving family wills, property related documents, family members are the probable culprits. So, the resemblance and differences in the characteristics of family members is an important area of study. Handwriting, also known as brain writing is found to be significantly different in males and females. Due to hormonal changes and physiological differences among the different genders, the neuromotor functioning of the brain is also affected which eventually affects the thinking manner of the two, thereby causing the variations in the handwriting. There are discriminatory features which are observed in the writing of males and females which may help in the determination of the gender of the writer as well as the genotypic inheritance of certain characteristics. A detailed review of literature has been performed on the studies in various repositories, databases and scientific portals.

Keywords: Inheritance; Gender; Handwriting; Hormonal Changes; Neuromotor Functioning.

INTRODUCTION

One of the prime concerns in forensic practice is identification and determination of individuality. Fingerprints, foot prints, lip prints, ridge density, etc. are reliable sources for identification and determination of sex. (Badiye *et al.,* 2016a, Badiye and Kapoor 2016b,

Bansal, *et al.,* 2014, Gupta *et al.,* 2015, Kapoor and Badiye 2015a, 2015b, Krishan *et al.,* 2011, Tsuchichashi, 1974). Handwriting is also a reliable source that has an important role in gender identification. The significance of documents in civil and criminal cases is largely dependent on the origin or authorship of the document (Huber & Headrick, 1999). For the authentica-tion of the questioned document, handwriting is conside-red to be an important evidence (Kelly & Lindblom, 2006).

Handwriting Forensics has been in use since a longer time with general acceptance (Sharma, 2012). Handwriting refers to different forms of writing by a writer as directed by his brain regardless of whether the writing is done with the arm, hand, foot & toes, etc. It is acquired during the early stages of life. This skill is a combination of unique movements of fingers, wrist and arm as per the directions of the brain. A consistent art of making these documents, the shapes of the letters, strokes and their connection, when fully developed becomes an individual writing style of a person. Once graphic maturity is achieved, different aspects of writing act become habitual and well-established (Morris, 2000).

Handwriting is a neuro muscular action which is dependent on the coordinated movement of the hand and eye as well as on the cognitive skill of a person. For a scientific basis of handwriting examination, it is important that handwriting should be examined under different circumstances. Genetics has an important role in the development of handwriting of a person (Saini *et al.,* 2015). Similarities have been observed in the handwritings of parents and siblings. Feminine and masculine hormones have an effect on the cognition ability of a person which may account for the variations in the cognitive skills, thereby causing distinctions in the handwriting of males and females (Núñez, *et al.,* 2020).

MATERIALS & METHODS

Handwriting is one of the most complex tasks performed by individuals. Formation of handwriting comprises the sensory motor control mechanisms involving various cerebral activities associated with rational thinking, emotions, communication, etc. This article reviews the previous studies carried out for the gender determination from handwriting, inheritance of handwriting characteristics from parents to biological off-springs and their resemblance among family members. An online literature search was done in google scholar and Science direct using the keywords such as 'effect of gender on handwriting'. 'inheritance of handwriting features', 'handwriting analysis' published during the year 2011-2020. A total of 10 studies from science direct and 5 from google scholar were selected and reviewed. The study had no limitations of the sample size, but restricted to the ones reported in English language only.

RESULTS & DISCUSSION

Gender Identification

Gender Identification has gained much attention due to its applications in different fields, especially in forensics. Forensic Examiners need to identify the gender for narrowing down the suspect's pool in cases involving handwriting examination. Various studies have validated the relationship between handwriting and gender.

An online approach was adopted to study the handwriting of males and females and the performance of assessed while copying a house drawing task, writing words in capital letters and writing sentences with particular focus on number of strokes and time categories of features of handwriting (Cordasco *et al.,* 2020)

A new approach (Kernel Mutual Information) for the prediction of gender from handwriting was proposed by the researchers that focussed on feature selection. Features like orientation, roundedness, curvatures and slant were extracted from the handwriting of males and females. Two databases were used involving the samples in different languages (English, Arabic and Chinese). Identification performance was analysed using text-dependent & test-independent modes and script dependent & script-independent modes (Bi *et al.,* 2019).

Gender classification was done from offline multiscript handwriting images using oriented Basic Image Features. The whole system was evaluated on the subsets of the QUWI database of English and Arabic language writing samples by the experimental protocols of ICDAR 2013, ICDAR 2015 and ICFHR 2016 gender classification competitions with the classification rates of 71%, 76% and 68% respectively (Gattal *et al.,* 2018).

By the character analysis of handwriting, it was possible to determine gender with the help of a decision tree formation and computer algorithms. A total of 133 attributes were studied for handwriting analysis and determination of gender. With ID3 algorithm, 93.75% success rate was achieved (Topaloglu and Ekmekci, 2017).

A wavelet-based approach was proposed for gender determination using the off-line images of the hand-writing. Writing images were considered as textures that were further decomposed to a series of wavelet sub-bands and extended to data sequences. The performance level was analysed on QUWI and MSHD databases and success rate of classification of 80% was achieved (Akbari, 2017).

Handwriting samples were examined by feature extraction and z-test was applied to study the variations in features of handwriting in males and females. Significant findings were obtained and were suitable to be used for gender differentiation (Upadhyay *et al.,* 2017).

Various features of handwriting were classified into micro and macro and were used for the discrimination of handwriting on the basis of gender identifying features (Sahu *et al.,* 2017).

Handwriting analysis for gender identification was done using the offline method. This highlighted the importance of local features analysis for gender determination with an accuracy level of 94.7% whereas with global features it was 81%. This system investigated the possibilities of language-dependent identification which has practical value in forensic and data mining applications (Ibrahim *et al.,* 2014).

A statistical study of different characteristic elements of handwriting was conducted to ascertain the gender of the writers and encouraging results were obtained which could be used for gender identification (Kumar *et al.,* 2013).

Shape description techniques like curvature function, Fourier descriptors and target angle function have been used to analyse the variations of handwriting in males and females. Quantitative variations in the spectral bands of direction of movement, speed of direction change, curvature and average bending energy showed their usefulness in the automatic gender handwriting classification system (Sokic *et al.,* 2012).

Inheritance of handwriting Features

Environment and genetic influence were examined on handwriting of monozygotic twins. Basic similarities were observed in the handwriting characteristics such as style. Alignment, curve, arc, loop formation (Ahuja *et al.,* 2018).

Manual analysis of handwriting samples of parents and off-springs showed high level of similarities in characteristics such as shading, pen lifts, connecting strokes, entry strokes and alignment. Higher degree of similarities was observed in the entry strokes of father and son followed by son and mother (Kiran and Sridhar, 2017).

Similarities in handwriting characteristics of twins and siblings were studied. Slant and position of dots in letter 'i' and 'j' were found to be most useful in differentiation of handwriting of siblings and twins. And inference regarding the influence of genetics and environment could be drawn from the findings.

Inheritance of handwriting features from parents to biological off-springs were examined. Computational features based on MATLAB software were used to study the resemblance in the handwriting features. Similarities were observed in handwriting of son and father due to the influence of same sex and dominance of male gene (Saini *et al.,* 2015).

Computational method based on MATLAB was used to study the resemblance of slant in the handwriting of closed genotypic family members. Results were statistically significant and verified using chi-square test. When both the parents had similar slant pattern, the off-springs showed the similar slant pattern (Saran V. *et al.,* 2013).

CONCLUSION

Detection of gender from the handwriting characteristics and their resemblance among closely related genotypic family members is an important area of research problem and has its applications in identification of writer, forensic document examination and other psychological studies.

Demographic attributes like age, handedness, gender, race, etc. have also been reported to be investigated using the handwriting characteristics.

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