

Barbara Gawda *

Lack of evidence for the assessment of personality traits using handwriting analysis

Abstract: *Background:* The aim of the study is to clarify the beliefs and numerous doubts about the possible identification of personality in handwriting. The purpose of the described studies was to show an association between personality traits and handwriting features. The author aimed to verify whether or not there are any specific characteristics of writing in relation to personality traits. | *Method:* Two different studies have been described. A different number of subjects participated in the investigations and different techniques for personality assessment were used; however, the same set of handwriting features was analyzed in each study. In the first study the NEO-FFI (n=260) was used, while the EPQ-R (n=180) was used in the second study. The graphic characteristics of the handwriting samples were examined by forensic experts. | *Results:* The correlations between the personality traits and handwriting features were counted. The results showed that there were few significant correlations between handwriting parameters and personality traits, as measured by the NEO-FFI and EPQ-R. | *Conclusions:* No writing characteristics were specific to personality traits. There is no evidence for assessment of personality on the base of handwriting.

Key words: assessment, handwriting analysis, personality traits

Introduction

Graphological assessment based on handwriting analysis is widespread in many countries. In fact, there is a number of private schools where graphology is taught. Further, there are associations for graphologists, and in some countries the Ministry of Education officially recognizes academic studies in graphology. Graphological assessment is utilized for personal recruitment and personal selection; however, the scientific research pertaining to handwriting analysis has generated controversial data (Tett & Palmer, 1997), and this is why the assessment of personality using handwriting remains questionable (Bushnell, 1996; Furnham, Chamorro-Premuzic & Callahan, 2003).

The belief that one's personality is reflected in one's handwriting has been strengthened by graphological theories. Theories involving an association between personality and handwriting arose from the French (Crépieux - Jamin, 1960), German (Klages, 1947; Wallner, 1971),

Swiss (Pulver, 1953), and Italian schools of graphology (Torbodoni & Zanin, 1993). The roots of hypothetical connections between personality and handwriting are related to the concept of individualization of graphical movement (gestures). This concept explains that graphical gestures for any given individual are unique, individualized, and distinctive. This idea has become the basis for forensic handwriting document investigation (Kirk, 1953). The unique form of the graphical movement is a result of the psychophysiological individualization, motor equivalence and motor memory (Wing, 2000).

There is still no a justifiable theory which explains the associations between handwriting and personality. The scientific efforts aimed at identifying a link between handwriting and personality have yielded ambiguous results. There are a number of studies which support the idea of a connection between personality and writing (Keinan & Eilat-Greenberg, 1993; Rafaell & Drory, 1988; Van Rooij & Hazelzet, 1997; Wellingham-Jones, 1989). In contrast,

* Maria Curie-Skłodowska University, Department of Psychology, Plac Litewski 5, 20-080 Lublin, Poland, bgawda@wp.pl

there are also studies which do not present any evidence for the possibility that personality is expressed in the graphical characteristics of handwriting (Bushnell, 1996; Eysenck & Gudjonsson, 1986; Furnham & Gunter, 1987; Nevo, 1989; Peebles, 1990). These studies in psychology have either, correlational or comparative forms. The comparative studies aim to compare the diagnosis based on handwriting formulated by graphologists and on personality questionnaire formulated by psychologists. The example of comparative study may be the study which was conducted by Eysenck (1945). It demonstrated that graphologists assessed personality traits of 50 patients at above chance level, while non-graphologists assessed personality on the basis of handwriting at a chance level. Another study was described by Netter and Ben-Shakhar (1989). They found no differences between prognosis formulated by graphologists and non-graphologists (the authors asked graphologists to judge the profession). Formulation of prognosis about profession based on any psychological technique is arguable, and this is why this limitation may refer to the several psychological techniques, not only to the graphological analysis.

The correlational research concerns the examination of the strength of associations between handwriting features and personality questionnaire results. Extra-introversion is one of the most frequently tested personality traits in relation with handwriting. Although several studies addressing this personality trait has been completed, it is impossible to conclude that the associations between handwriting and extra-introversion trait are confirmed. For instance, Williams, Berg-Cross, & Berg-Cross (1977) found the correlations between handwriting parameters (slant, upper zone height, middle zone height) and results in extra-introversion measured by Eysenck's MPI. The research made by Lester, McLaughlin and Nosal (1977), and by Rosenthal and Lines (1978) have not confirmed the above findings. Eysenck & Gudjonsson (1986) found weak associations between MPI and handwriting characteristics (it is important to notice, that their study had the significant limitation, they examined the correlations between assessment of respondents' handwriting analyzed by one graphologist and the MPI results; a graphologist assessed handwriting, and then she filled in the MPI as she thought would have been done by the respondents). Likewise, Furnham and Gunter's research (1987) has not confirmed the validity of the personality assessment (also based on Eysenck's MPI) with the use of handwriting analysis. In the Polish study with the use of this inventory, Gawda (1994) found weak or average correlations between handwriting and extra-introversion, and no correlation between neuroticism and handwriting (the number of participants was small; 37 persons). The similar procedure to the Eysenck and Gudjonsson's procedure, was used in the study conducted by van Rooij and Hazelzet (1997). Handwriting of the subjects with the highest results (3 – 6 persons) in the extra-introversion scale was analyzed by 10 graphologists from Nederland Society of Graphology. They were asked to assess extraversion/introversion on the basis of handwriting of each participant. Then, graphologists

were asked to fill the questionnaire in a way that they would have been the chosen participants. Correlation between graphologists' scores (in extraversion/introversion) and graphologists' scores in handwriting was very high ($r = .96, p < .001$). It shows probably, that the language used by graphologists and psychologists is similar. In sum, the study was questionable; graphologists have been asked to imagine extravert/introvert person and to fill the questionnaire as the extravert/introvert subject. In fact, this study have shown no evidence for the associations between handwriting and extraversion. The important limitations of this study is questionable procedure, and very small size of the sample (3-6 participants) (van Rooij & Hazelzet, 1997).

The previous verifications of the associations between handwriting characteristics and results of the NEO-FFI were negative. There have been found single and weak correlations between extraversion and handwriting (Furnham, Chamorro-Premuzic & Callahan, 2003). Certain confirmation of associations between extraversion and size of middle zone of handwriting was reported by Åström and Thorell (2008). The Polish study with the use of this inventory has not shown significant correlations between handwriting and personality among females (Frydrych, 2006). Another Polish study showed that participants extraversion's level may be assessed from the middle zone size, width and forms of the letters, connection forms, and word spacing (Górska & Janicki, 2012). Although the study conducted by Górska and Janicki (2012) was based on a large sample, it had significant limitations. First, the discrimination of the personality trait concerned only high versus non-high extraversion levels, and second, the coding system for handwriting was binary (such as slant left, and other slant). Which is why the conclusions about possibility of assessing extraversion on the basis of handwriting are not justified.

There is also a group of studies presenting the use of handwriting analysis in personnel selection; assessment of the work competence in successful women, or prediction of academic success. In Wellingham-Jones' study (1989), handwriting of two groups of women were compared, and the significant differences were found between "successful" women and "not-so-successful" women. This study, however, had no relation with assessing the personality on the basis of handwriting. Another study concerned hypothetically the prediction of academic success as well as students' satisfaction on the basis of handwriting. The authors found the differences between handwriting of students with good and bad marks. However, it mainly refers to the readability and aesthetic quality of students' scripts, not to the diagnosis of their personality (Lowis & Money, 2001; Mandevillwe, Stutler & Peebles, 1992). In fact, these studies do not refer to the examination of the associations between handwriting and personality.

The presented review of relevant literature indicates that, the research on personality and handwriting has significant limitations, and has generated controversial data. That is why, the purpose of the two current studies was to demonstrate with methodological control whether or not there is an association between personality traits and

handwriting characteristics. The graphical features have been chosen on the basis of the previous studies (Gawda, 1994; Williams, Berg-Cross & Berg-Cross, 1977).

Study 1 method

Participants

The sample consisted of 260 undergraduate students (130 males and 130 females). The students were 20-21 years old ($M = 20.5$ years, $SD = 0.5$) and at the same level of education (the students were in their second year at different faculties). The students were healthy, right-handed, and with no vision, speech, or motor impediments. The students did not exhibit any psychological or neuropsychiatric impairments (the participants completed a questionnaire to determine relevant characteristics).

Measures

The Big Five Model of Personality

The NEO-FFI (60 items with a 5-point Likert scale: 1 = strongly disagree to 5 = strongly agree; Costa & McCrea, 1985, Polish adaptation by Zawadzki, Strelau, Szczepaniak, & Śliwińska, 1998) was used to assess personality. The NEO-FFI measures the following five personality traits: neuroticism; extraversion; agreeableness; conscientiousness; and openness. The five scales were taken into consideration. Reliability and validity of this inventory are suitable (Zawadzki, et al, 1998).

Handwriting analysis

Forensic experts specialists in document and handwriting expertise analyzed all handwriting samples (they have more than 10 years of experience in handwriting analysis and document expertise). We did not employ the graphologists, but the forensic document experts, because we aimed to assess the graphical parameters of handwriting with objectivity, without any influence of graphological ideas. Three forensic experts worked independently. They have been not informed about the aim of the study and did not know anything about the authors of the handwriting samples. The forensic experts assessed the graphical parameters of writing with the use of the objective criteria (according to the graphical-comparative method described in the literature related to the document investigation (Kegel, 2000; 2002). The texts of the writing samples were the same length. The forensic experts counted the number of letters of each specific type, such as the number of convex (arcade) forms of "m" in the text. The forensic experts specified the characteristics of the handwriting. The scores were averaged, then used in the statistical comparisons. The description of the graphical parameters was based on the Catalogue of Polish Expertise School of Handwriting (Hołyst, 2004). The following graphical characteristics were used in the study. The possible forms of impulse (the manner by which the letters in a word are connected) were as follows: letter; syllable, word; and phrase. The number

of written words with the same impulses was recorded. The different forms of construction of letters (the number of each type of letter was recorded), such as the convex (arcade), concave (garland), angular, oval, and linear forms of the letters "m" and "n," the open shape of the oval of "a," the closed shape of the oval of "a," and the loop in the ovals of letters, were analyzed. The size of letters was measured (small, medium, large, and very large). The form of the shape of the dot (diacritic sign) over the letters "i" and "j" was analyzed, such as circle, point, and comma shapes. The pressure of letters was described with respect to heavy, medium, and slight. The number of letters written with a tremor (trembling), as well as the letters written with ataxia (sudden disturbances of movement), were counted. The different directions (horizontal, sinusoidal, descending, and rising) and number of the basic line were analyzed. The initial strokes of the letters as hook- or loop-like were counted. The final strokes of the letters as cut off or sharp were recorded. The types of slant were recorded, such as left, right, vertical to the basic line, and mixed. The word and line spacing were measured, and the size of the upper, middle, and lower zones (Hołyst, 2004; Koziczak, 1997).

Procedure

Each participant completed the NEO-FFI, and a questionnaire to determine relevant characteristics for the analysis of hand movement, such as age, educational level, occupation, speech, vision, motor impairments, neurological diseases, and so on. Then, each person was asked to write the same text on a single piece of paper without lines that was dictated at a medium speed, and done in order to standardize the conditions. All of the texts were written under the same conditions. The participants were sitting comfortably during the writing tasks, they used the same brand of ballpoint pen. Also light, noise level, and writing base used in the study were similar.

Statistical analysis

The inter-rate agreements between the scores of three forensic experts were calculated for each graphical variable (W-Kendall). The scores were very similar (rates between .97 and .99). The distribution of each variable was tested. The majority of variables had a distribution similar to the normal, but some of the variables did not have a normal distribution, such as the number of letters with a tremor and the circle form of dots in the letters "i" and "j." Then, the τ -Kendall / r Pearson correlations (for these variables which have the appropriate measures of dispersion, skewness, kurtosis), were calculated between neuroticism, extraversion, agreeableness, conscientiousness, openness, and all graphical variables.

Study 1 results

The purpose of this study was to establish the association between handwriting and personality traits. The following four parameters of handwriting were correlated with neuroticism, as measured by the NEO – FFI: medium size of letters; medium pressure; medium

size of the middle zone; and word impulse. Higher scores in neuroticism were related to a less frequent medium size of letters, medium pressure, medium size of the middle zone, and word impulse of handwriting. Higher scores in extraversion were correlated with more frequent medium size of letters, medium pressure, and medium size of the middle zone. Agreeableness correlated with the medium size of letters, medium pressure, and the size of the lower zone. Consciousness was correlated with the medium size of letters, medium pressure, and the horizontal direction of the basic line of handwriting. The scores in openness were related to the linear form of the letters “m” and “n,” medium pressure, and syllable impulse. Each personality trait measured by a five-factor model, was correlated with medium pressure; four traits correlated with medium size of the letters; and two traits were related to middle zone size. All of these correlations were significant, but small or average (table 1 - page 77).

Study 2 method

Participants

The sample consisted of 180 undergraduate students (90 males and 90 females). The students were 23–24 years old ($M = 23.5$ years, $SD = 0.5$) and had the same level of education (different faculties). The students were healthy, right-handed, and without any vision, speech, or motor impediments. The students did not exhibit any psychological or neuropsychiatric impairment (information is based on the completed questionnaire).

Measures

EPQ-R

The EPQ-R [100 items; Polish adaptation by Brzozowski & Drwal (1995) with yes/no possible responses] was used to assess the following three major dimensions of personality: extraversion; neuroticism; and psychoticism. The questionnaire, and his Polish version has been shown to have good psychometric properties (Brzozowski & Drwal, 1995; Eysenck, Eysenck & Barret, 1985).

Handwriting analysis

The same list of handwriting characteristics as in study 1, was used in this study. The same forensic experts examined 180 documents, which were of the same length, as in study 1.

Procedure

The procedure was the same as in study 1. Another sample was tested in the second study. The aim of this study was also the same as study 1. We verified whether or not any handwriting characteristics were associated with personality traits, as measured by the EPQ-R.

Analysis

The inter-rate agreements between the scores of the three forensic experts were calculated for each graphical variable (W-Kendall). The scores were similar (rates between .97 and .99) to the results from the first study. Then, a distribution of the variables was tested. A τ -Kendall/r Pearson for correlation was calculated between neuroticism, extraversion, psychoticism, and all graphical variables.

Study 2 results

The correlations between handwriting and the EPQ-R scales were not significant. We did not find any statistically significant correlation between psychoticism, extraversion, and handwriting parameters. There was only one average significant correlation found, and this was between neuroticism and the sinusoidal basic line of handwriting ($\tau = .24$, $p < .01$, $r^2 = .05$).

Discussion

The results systematize the diversity of graphological data on associations between handwriting and personality. There have been found no specific features in handwriting of people with extra-introversion, neuroticism, psychoticism, agreeableness, consciousness, neither openness. The current research was conducted in accordance with scientific rules. The methodological requirements were strict. We controlled a set of important variables which may have an impact on handwriting, including handedness, age, and lack of signs, motor, or neuropsychiatric impairment. Furthermore, the analysis of handwriting was made with the objective criteria. The forensic experts examined all handwriting samples. To our knowledge, no research exists on association between handwriting and personality with use of the document forensic expertise. We stress on this, because there are numerous graphological/psychological studies with considerable limitations, and lacking any methodological control. The most frequent limitations of studies testing the associations between handwriting and personality are following: too small number of participants (i.e. example, Rooij & Hazelzet, 1997; Tett & Palmer, 1997; Williams, Berg-Cross & Berg-Cross, 1977); incoherent theories for personality and handwriting as a basis of the analysis; lack of control groups or inappropriate selection of control groups; lack of control of fundamental factors, such as age, sex, intellectual level, health, handedness, type of ball-pen, type of writing basis, incorrect procedure of writing tasks, which may have an impact on handwriting (i.e. Williams, Berg-Cross & Berg-Cross, 1977; Furnham, Chamorro-Premuzic & Callahan, 2003; King & Koehler, 2000; Tett & Palmer, 1997). Unclear system of coding of the handwriting parameters was also significant limitation of many studies (i.e. binary coding in the study conducted by Górska and Janicki, 2012; or unclear coding in the studies conducted by Furnham, Chamorro-Premuzic and Callahan, 2003). In the last cited study, the variables such as slant and color of ink have been analyzed (but it was not explained

Table 1. Correlations (τ – Kendall / r – Pearson) between graphical characteristics of handwriting and five-factor scales

| Graphical traits | Neuroticism | Extraversion | Agreeableness | Conscientiousness | Openness |
|--------------------|----------------|---------------|---------------|-------------------|-----------------|
| Convex: m, n | (τ).02 | (τ).03 | (τ).00 | (τ).01 | (τ).01 |
| Garland: m, n | (τ).04 | (τ).02 | (τ).01 | (τ).01 | (τ).01 |
| Angular: m, n | (τ).04 | (τ).02 | (τ).01 | (τ).01 | (τ).01 |
| Oval: m, n | (τ).03 | (τ).02 | (τ).01 | (τ).02 | (τ).01 |
| Linear: m, n | (τ).02 | (τ).03 | (τ).01 | (τ).02 | (τ).34** |
| Shape „a“: open | (τ).02 | (τ).03 | (τ).04 | (τ).02 | (τ).02 |
| Shape „a“: closed | (τ).10 | (τ).03 | (τ).05 | (τ).02 | (τ).02 |
| Loops in ovals | (τ).10 | (τ).00 | (τ).05 | (τ).02 | (τ).00 |
| Size: small | (τ).09 | (τ).07 | (τ).12 | (τ).09 | (τ).02 |
| Size: medium | (r)-.23** | (r).28** | (r).33** | (r).21* | (r).03 |
| Size: big | (τ).02 | (τ).08 | (τ).02 | (τ).03 | (τ).09 |
| Size: very big | (τ).04 | (τ).00 | (τ).00 | (τ).03 | (τ).00 |
| Dot „i, j“: circle | (τ).08 | (τ).06 | (τ).00 | (τ).02 | (τ).08 |
| Dot „i, j“: point | (τ).08 | (τ).03 | (τ).00 | (τ).02 | (τ).08 |
| Dot „i, j“: comma | (τ).08 | (τ).13 | (τ).00 | (τ).02 | (τ).09 |
| Pressure: heavy | (τ).07 | (τ).03 | (τ).01 | (τ).03 | (τ).20 |
| Pressure: medium | (r)-.24** | (r).19** | (r).32** | (r).34** | (r).42*** |
| Pressure: slight | (τ).04 | (τ).06 | (τ).09 | (τ).06 | (τ).03 |
| Pressure: tremor | (τ).11 | (τ).02 | (τ).01 | (τ).07 | (τ).03 |
| Pressure: ataxies | (τ).10 | (τ).02 | (τ).01 | (τ).07 | (τ).03 |
| Line: horizontal | (r).06 | (r).03 | (r).09 | (r).37** | (r).02 |
| Line: sinusoidal | (τ).04 | (τ).07 | (τ).09 | (τ).01 | (τ).02 |
| Line: descending | (τ).08 | (τ).01 | (τ).01 | (τ).02 | (τ).04 |
| Line: rising | (τ).09 | (τ).00 | (τ).03 | (τ).02 | (τ).04 |
| Initial: loop-like | (τ).06 | (τ).06 | (τ).04 | (τ).00 | (τ).00 |
| Initial: hook-like | (τ).05 | (τ).06 | (τ).05 | (τ).04 | (τ).01 |
| Final: cut off | (τ).08 | (τ).07 | (τ).05 | (τ).05 | (τ).03 |
| Final: sharp | (τ).03 | (τ).07 | (τ).06 | (τ).06 | (τ).03 |
| Slant: left | (τ).00 | (τ).01 | (τ).00 | (τ).05 | (τ).03 |
| Slant: right | (τ).00 | (τ).03 | (τ).01 | (τ).06 | (τ).04 |
| Slant: vertical | (τ).01 | (τ).12 | (τ).01 | (τ).06 | (τ).09 |
| Slant: mixed | (τ).12 | (τ).07 | (τ).01 | (τ).03 | (τ).02 |
| Mean word spacing | (r).11 | (r).06 | (r).12 | (r).04 | (r).03 |
| Mean line spacing | (r).10 | (r).02 | (r).08 | (r).06 | (r).06 |
| Size upper zone | (r).04 | (r).03 | (r).03 | (r).02 | (r).05 |
| Size middle zone | (r)-.26** | (r).18* | (r).04 | (r).02 | (r).05 |
| Size lower zone | (r).09 | (r).00 | (r).21* | (r).02 | (r).01 |
| Impulse: letter | (τ).10 | (τ).01 | (τ).02 | (τ).00 | (τ).02 |
| Impulse: syllable | (r).12 | (r).02 | (r).02 | (r).09 | (r).42*** |
| Impulse: word; | (τ).21* | (τ).00 | (τ).01 | (τ).09 | (τ).12 |
| Impulse: phrase | (τ).00 | (τ).00 | (τ).01 | (τ).00 | (τ).01 |

Note. * - $p < .05$; ** - $p < .01$; *** - $p < .001$

how slant has been assessed, and correlations between color of ink used by participants [participants wrote texts of an exam] and their personality traits have been counted (Furnham, Chamorro-Premuzic & Callahan, 2003). There are also studies during which participants are asked to say whether the psychological or graphological opinions about themselves are correct. The procedure of this kind of studies was questionable as it is seen in the study when 120 persons had to rank the opinions about themselves formulated on the basis of 16PF Cattell and opinions made by graphologists (Bushnell, 1996). The conclusion was that participants ranked the handwriting reports about themselves at a chance level, and the personality reports at above chance level. Further shortcomings found in studies are the confusion, superficial character of the graphological analysis, difficulty in understanding the language presented by graphologists, great number of incoherent and contradictive elements, as well as negligence of the graphological analysis (Fiori 1986, 1987; Klimoski & Rafaeli, 1983).

The current findings showed a small number of graphical characteristics related to the main personality traits. The number of significant correlations found in both studies is at a chance level. These studies showed that there are some associations between personality traits and handwriting, but there was no possibility to assess the personality traits on the basis of these graphical parameters. The example of such difficulty is shown by the ambiguous result when a medium size of letters, or medium pressure correlate with all personality traits: neuroticism, extraversion, agreeableness, conscientiousness, and openness. It is impossible to differentiate the personality traits on the basis of a medium size of letters, or medium pressure.

There are some data that indicate that emotional conflicts and psychiatric impairments have an impact on muscular tension and affect handwriting pressure (Caligiuri, Teulings, Filoteo, Song & Lohr, 2006; Peeples, Searls & Wellingham – Jones, 1995; Tucha, Paul, Mecklinger, Eichhammer, Klein & Lange, 2003). These findings may refer to the expression of neuroticism in handwriting, but the present results related to neuroticism do not support this thesis. The handwriting characteristics which may hypothetically correlate with neuroticism, such as trembling or ataxia, have not been linked to this personality trait.

The present findings confirmed the results of those studies which suggested minimal value of handwriting analysis in personality assessment (Neter & Ben-Shakar, 1989; Nevo, 1989; Peeples, 1990; Sappington & Money, 2003). The current findings are in line with the results described by Dazzi and Pedrabissi (2009) based on two studies with use of the Big Five Questionnaire. Correlations between the Big Five Questionnaire and graphological evaluations did not confirm the capability of handwriting analysis to measure the Big Five personality traits. The similar conclusion was formulated by Thiry (2008), Furnham, Chamorro-Premuzic, and Callahan (2003), and Frydrych (2006).

The possible interpretation of the current findings may refer to those neuropsychological data, which suggest the independence of personality and motor gesture

(Lieberman, 1996; Morgan & Lilienfeld, 2000). Personality is very difficult to define on a neuropsychological level. The cerebral and neuronal mechanisms of handwriting are also very complex, which is why it is difficult to define the relationship between these two phenomena, personality and handwriting. It is possible that there is no relationship between motor gesture in writing and personality. The interesting result regarding the independence of personality and motor gestures has been reported by psychopathologists (Morgan & Lilienfeld, 2000). Specifically, it was stated that the personality disorder may not be accompanied by a handwriting disorder, and the handwriting disorder may not be accompanied by the personality disorder (Morgan & Lilienfeld, 2000); however, these two types of disorders may manifest together (Lieberman, 1996).

Conclusion

We conclude that it is impossible to render an opinion about the Big Five personality traits on the basis of handwriting analysis. We did not find the specific writing features for each personality trait measured by EPQ-R. The present studies did not show any confirmation that personality traits, such as neuroticism, psychoticism, extraversion, agreeableness, conscientiousness, and openness, are reflected in person's handwriting.

References

- Åström, J., & Thorell, L. (2008). Graphometric variables of one's signature: II correlations with measures of perception, cognitive functions and personality. *Perceptual & Motor Skills*, 107, 197-221.
- Brzozowski, P., & Drwal, R. Ł. (1995). *Kwestionariusz Osobowości Eysencka. Polska Adaptacja*. Warszawa: PTP (Eysenck Personality Questionnaire, Polish version).
- Bushnell W. R. (1996). A comparison of the validity of handwriting analysis with that of the Cattell 16 PF. *International Journal of Selection and Assessment*, 4, 12-17.
- Caligiuri, M.P., Teulings, H.L., Filoteo, V., Song, D., & Lohr, J.B. (2006). Quantitative measurement of handwriting in the assessment of drug-induced parkinsonism. *Human Movement Science*, 25(4-5), 510-522.
- Costa, P. T., & McCrae, R. R. (1985). *The NEO personality inventory manual*. Odessa, FL: Psychological Assessment Resources.
- Crépieux-Jamin, J. (1960). *L'écriture et le caractère*. Paris: P.U.F.
- Dazzi, C., & Pedrabissi, L. (2009). Graphology and personality: an empirical study on validity of handwriting analysis. *Psychological Reports*, 105, 1255-1268.
- Eysenck, H. J., & Gudjonsson, G. (1986). An empirical study of validity of handwriting analysis. *Personality and Individual Differences*, 7, 263-264.
- Eysenck, S. B. G., Eysenck, H. S., & Barret, P. (1985). A revised version of the Psychoticism scale. *Personality and Individual Differences*, 6, 21-29.
- Fiori, A. (1986). Presentation of a Research on Character Compatibility of Couples. Part I of the Report, *Rivista Internazionale di Psicologia e Ipnosi* 27, 4, 325-332.
- Fiori, A. (1987). Presentation of a Research on Character Compatibility of Couples. Part II of the Report, *Rivista Internazionale di Psicologia e Ipnosi* 28, 1-2, 79-91.
- Frydrych, D. (2006). Związek grafizmu z cechami osobowości kobiet samotnych. In B. Gawda (Ed.), *Grafizm jako forma ekspresji*. Lublin, UMCS, Pp. 43-66 [Graphism as the expressive form].
- Furnham, A., & Gunter, B. (1987). Graphology and personality: another failure to validate graphological analysis. *Personality and Individual Differences*, 8, 433-435.
- Furnham, A. Chamorro-Premuzic, T., & Callahan, I. (2003). Does graphology predict personality and intelligence? *Individual Differences Research*, 1 (2), 78-94.

- Gawda B. (1994). Diagnoza introwersji, ekstrawersji i neurotyzmu na podstawie pisma. *Studia Psychologiczne*, 32, 59-66 (Psychological Research).
- Górska, Z., & Janicki, A. (2012). Recognition of extraversion level based on handwriting and Support Vector Machine. *Perceptual & Motor Skills*, 114, 3, 857-869.
- Holyst, B. (2004). *Kryminalistyka*. Warszawa: PWN (Criminalistics).
- Kegel, Z. (Ed.) (2000). *The questions of document's evidence*. Wrocław: University of Wrocław.
- Kegel, Z. (Ed.) (2002). *Contemporary Problems of Proof From a Document*. Wrocław: University of Wrocław.
- Keinan, D. & Eilat – Greenberg, S. (1993). Can stress be measured by handwriting analysis? The effectiveness of the analytic method. *Applied Psychology*, 42 (2), 153-170.
- King, R.N., & Koehler, D.J. (2000). Illusory correlations in graphological inferences. *Journal of Experimental Psychology: Applied*, 6, 336-348.
- Kirk, P. (1953). *Crime Investigation*. New York: Physical Evidence and Police Laboratory.
- Klages, L. (1947). *L'expression du caractère dans l'écriture*. Paris: Privat.
- Klimoski R. J., & Rafaeli A. (1983). Inferring Personal Qualities Through Handwriting Analysis, *Journal of Occupational Psychology*, 56, 3, 191-202.
- Koziczak, A. (1997). *Metody pomiarowe w badaniach pismoznawczych*. Kraków: Instytut Ekspertyz Sądowych (Measuring method in handwriting research).
- Lester, D., McLaughlin, S., & Nosal, G. (1977). Graphological signs for extraversion. *Perceptual & Motor Skills*, 57, 137-138.
- Lieberman, A. (1996). Adolf Hitler had post-encephalitic Parkinsonism. *Parkinsonism and Related Disorders*, 2(2), 95-103.
- Lewis, M.J., & Mooney, S. (2001). Examination performance and graphological analysis of students' handwriting. *Perceptual & Motor Skills*, 93, 367-381.
- Mandeville, R.G., Stutler, D.L., & Peebles, E.E. (1992). Students' ratings of college services and their scores on handwriting areas. *Perceptual & Motor Skills*, 75, 1227-1232.
- Morgan, A. B., & Lilienfeld, S. (2000). A meta-analytic review of the relation between antisocial behavior and neuropsychological measures of executive function. *Clinical Psychology Review*, 20, 1, 113-136.
- Neter, E., & Ben-Shakar, G. (1989). The predictive validity of graphological inferences: a meta-analytic approach. *Personality and Individual Differences*, 10, 737-745.
- Nevo, B. (1989). Validation of graphology through use of a matching method based on ranking. *Perceptual and Motor Skills*, 69, 1331-1336.
- Peebles, E.E. (1990). Training, certification, and experience of handwriting analysis. *Perceptual and Motor Skills*, 70, 1219-1226.
- Peebles, E. E., Searls, D. T., & Wellingham – Jones, P. (1995). Attention-deficit hyperactivity disorder: a longitudinal case study of handwriting characteristics. *Perceptual and Motor Skills*, 81, 1243-1252.
- Pulver, M. (1953). *Le symbolisme de l'écriture*. Paris: Stock.
- Rafaeli, A., & Drory, A. (1988). Graphological Assessments for Personnel Selection. Concerns and suggestions for research. *Perceptual and Motor Skills*, 66, 743-759.
- Rosenthal, D.A., & Lines, R. (1978). Handwriting as a correlate of Extraversion. *Journal of Personality Assessment*, 42 (1), 45-48.
- Sappington, J., & Money, M. (2003). Sex, gender role, attribution of pathology and handwriting tidiness. *Perceptual and Motor Skills*, 97, 671-674.
- Tett, R. P., & Palmer, C. A. (1997). The validity of handwriting elements in relation to self-report personality trait measures. *Personality and Individual Differences*, 22, 11-18.
- Thiry, B. (2008). Graphologie et personnalité selon le modèle en cinq facteurs. *Psychologie Française*, 53, 3, 399-410.
- Torbidoni, L., & Zanin, L. (1993). *Manuel de graphologie. Théorique et pratique*. Paris: Éd. Frison-Roche.
- Tucha, O., Paul, G.M., Mecklinger, L., Eichhammer, D., Klein, H.K., & Lange, K.W. (2003). Handwriting in schizophrenia. A kinematic analysis of handwriting movements. *The International Journal of Forensic Document Examiners*, 6 (1), 1-3.
- Van Rooij, J. J., & Hazelzet A. M. (1997). Graphologists assessment of extraversion, *Perceptual and Motor Skills*, 85, 919-1009.
- Wallner, T. (1971). Der Unterschied zwischen Schriftpsychologie und Graphologie. *Psychologie und Praxis*, 1, 1-8.
- Wellingham - Jones, P. (1989). Evaluation of the handwriting of successful women through the Roman-Staemfli psychogram. *Perceptual and Motor Skills*. 69, 999-1010.
- Williams, M., Berg-Cross, G., & Berg-Cross, L. (1977). Handwriting characteristics and their relationship to Eysenck's Extraversion-Introversion and Kagan's Impulsivity-Reflectivity dimensions. *Journal of Personality Assessment*, 41 (3), 291-298.
- Wing, A. M. (2000). Mechanisms of motor equivalence in handwriting. *Current Biology*, 10, 6, 245-248.
- Zawadzki, B., Strelau, J., Szczepaniak, P., & Śliwińska, M. (1998). *Inwentarz Osobowości NEO-FFI Costy i McCrae. Podręcznik*. Warszawa: Pracownia Testów Psychologicznych PTP (NEO-FFI Personality Inventory Manual, Polish version).