THE ELECTRONIC GRAPHIC TABLET –

AN INVESTIGATION IN GRAPHOLOGICAL VALIDITY

A STATISTICALLY BASED COMPARATIVE STUDY

BY

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ZURICH, DECEMBER 2010

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PICTURE IN FRONT :
Painting on Greek Vase, Δούρις (Douris), ca 480 B.C.: Scholars; the figure in the middle is writing on a wax tablet

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1. INTRODUCTION

The question about the validity of handwriting analysis has always been of fundamental interest. Yet, graphology still lacks good basic research. Since modern technology offers a quite new approach to measuring handwriting variables, we feel obliged to apply the very instrumentation. Thus, the aim of the presented research is to verify the congruence between the results of handwriting variables measured on an electronic graphic tablet, graphological evaluations, and psychometric tests by means of adequate statistical procedure. As graphological research still lacks fundamental studies, we hope to contribute in the improvement of validation, knowledge, and practice of graphology.

Based on a first study[1] carried out by gathering data from an electronic graphic tablet, we used the graphic material produced by 81 probands who gave handwritings samples as on the tablet as on normal paper. As the tablet is connected with a computer, the data are measured and registered by several parameters. Later, the same samples have been analysed independently by a group of six Swiss graphologists. Additionally two psychometric tests were exposed to the probands, and many of the numerous data were compared by several statistical methods.

2. HISTORICAL BACKGROUND

Graphology has been, from it's very beginning in the 16th century, a scientific approach to discovering man's mind, emotion, and expression of the latter in his very handwriting. In those times, the brain already was considered to be the organic material underlying intelligence, reason, understanding, and to be centre of psychophysical interaction.

The first ones to be interested in graphology were all physicians and university professors. Among them the very first is supposed to be Juan Huarte de San Juan from Andalusia: His book *Examen de ingenios para las sciencias*[2] consists in a kind of modern assessment to find out the individual's character in order to match with the most convenient branch of Studies. He was the first to describe the connections between mind and body, positioning neuropsychological theses on the psychophysical nexus in the human organism. In one chapter out of 25, he also comments graphology.

The next was Prospero Aldorisio who in Italy in his *Idengraphicus nuntius*[3] developed a complete graphological system with 72 axiomatic paragraphs, called *Idiography*. He considered handwriting, in modern words, as a "neuropsychological function". As far as paragraph 37, the graphical traits clearly depend on all mind, feelings, and body.

In 1622, the better known Camillo Baldo (or Baldi) wrote his *Trattato come da una lettera missiva si conoscano la natura e qualità dello scrittore*[4] which might have become a worthy foundation of modern graphology with emipiric observations. He distinguished the two principles: expression and portrayal, he interpreted by analogy and insisted on accurate critique of the material.[5]

[1] Peterka (2009)
[2] Huarte (1575)
[3] Aldorisio (1611)
[4] Baldo (1622)
[5] See also Pfanne (1961)

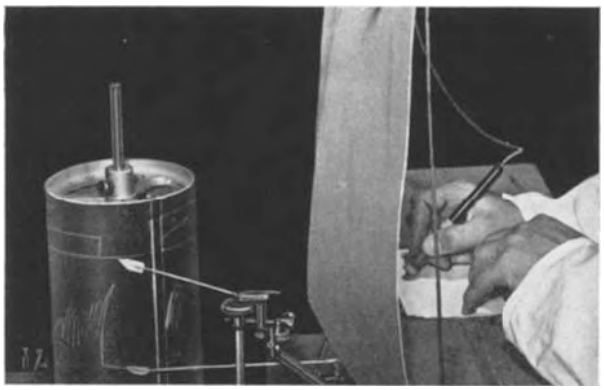
Since those times, scientific graphology, like the other branches of empiric science, has been based on exact observation, be it by describing, measuring, estimating, registering, and evaluating given facts.

The 19th century was the Industrial Age and, in general, dedicated to the development of all sorts of machines. As there was felt a need to register the devolution of the writing movement, in Germany there was born the idea to build machines to "weigh" handwriting pressure, to measure the speed of writing, and to register the pressure of the fingers on the pencil.

The first one to "weigh" the pressure in handwriting was Goldscheider[6] who built a pneumatic apparatus for the very purpose. In the following years, there were built a big number of similar machines to measure pressure, speed, and pressure of the fingers on the pencil; they were based either on pneumatic, mechanical, electromagnetic, electric, or combined techniques.[7]

Some of the most interesting among these numerous findings are those of the German Psychiatrist Emil Kraepelin[8] who in 1903 constructed a mechanical weighing machine for handwriting. In those times, any human expression was considered as a most valuable diagnostic sign, especially in psychiatric illnesses. He was interested especially in handwriting pressure, for this very element was considered as most important to differentiate various psychiatric and mental diseases. He also registered the pressure on the pencil.

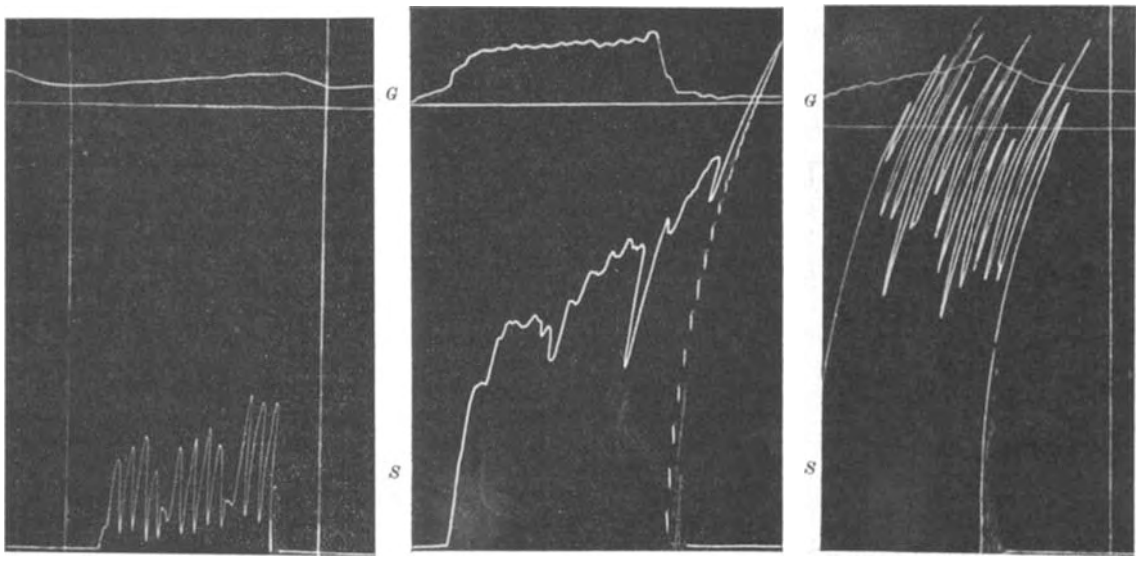
So handwriting, which is, as a psychomotor action, an enduring trace of human movement, was a very convenient tool in diagnostics. Kraepelin described particular disturbance of the movement supposed to indicate certain hints for psychiatric illness.



"Weighing Machine" for Handwriting Pressure

Indeed, he found that the pycnic type (associated to the bipolar illness) writes with a low and consistent pressure, the ectomorphic type, associated to the schizoid, shows an irregular, abruptly changing pressure on a higher level and, finally, the athletic, viscous type shows a progression of an increasing pressure which ends on the highest level.

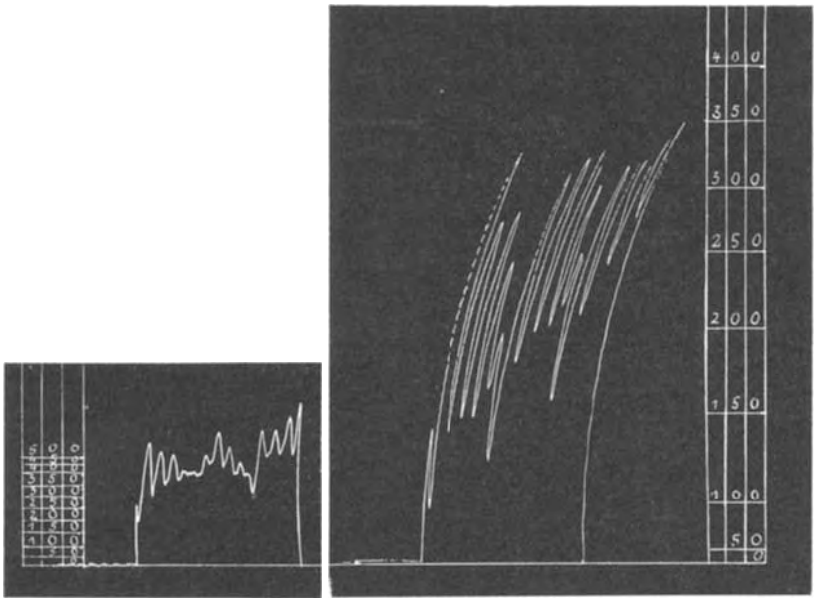
[6] Goldscheider (1892)
[7] See Steinwachs (1952)
[8] ibid.



Pycnic *Athletic* *Ectomorphic Type*

Typical Curves for Handwriting Pressure on Paper and Pressure on Pencil (above)

In the fifties of the 20th century, in Tübingen the "weighing machine" for handwriting pressure was further improved and refined e.g. by Friedrich Steinwachs.[9] The improvement led to show magnified the amplitude and, therefore, a finer demonstration of small deviations.



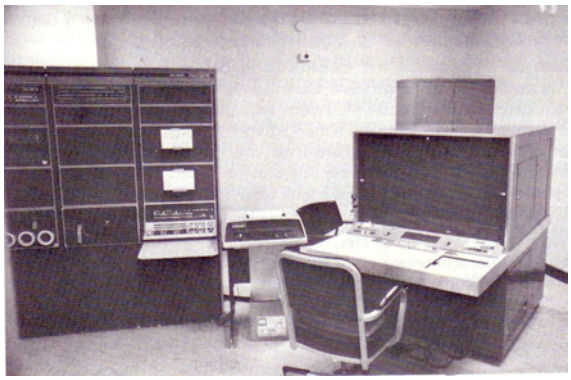
Curves produced by the older model of Kraepelin (left) and the more refined version of Steinwachs (right)

In the age of computers, finally, the possibility is given to measure most exactly handwriting variables.

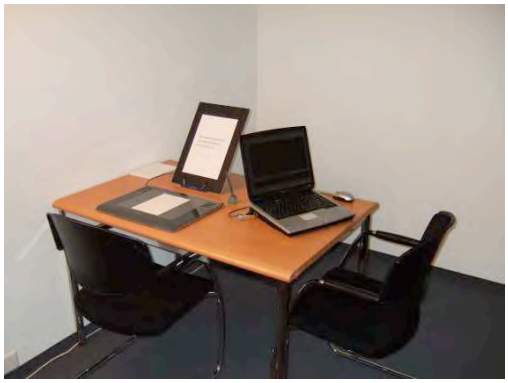
In the seventies, Thea Stein Lewinson[10] (USA) developed an apparatus to measure handwriting dimensions: the data were documented and gathered by a computer.

[9] Steinwachs (1952
[10] Stein Lewinson, Thea (1974)

After a similar construction in Germany, in Switzerland Kristin Bühler[11] developed a pressure sensor in form of a writing pencil to directly measure handwriting pressure.



1970: Apparatus with Computer for Measuring Handwriting Data



2010: Electronic Graphic Tablet CSWin with Instruction Sheet and Laptop

With the Electronic Graphic Tablet, nowadays for the first time we have the possibility to measure various handwriting characters most accurately at the same time and to register exactly numerous data electronically.

3. AIMS OF THE RESEARCH

The presented study consists of a preparatory practical and an analytical part. The practical (experimental) part includes the following steps:

- the measurement of the handwriting variables on the graphic tablet
- the taking the normal handwriting specimens from probands
- the carrying out of two psychometrical tests: d2 and NEO-FFI
- the evaluation of the handwriting specimens done by a group of experienced graphologists; they evaluated handwriting signs and psychological traits of probands.

The analytical part consisted of formal and logical analyses of the experimental data. The major aims were the following:

- to analyse the measured variables of the handwriting and to investigate dependences or correlations among them
- to investigate the concordance between involved graphologists, both over signs and traits
- to analyse the interdependencies and relations between handwriting signs evaluated by the graphologists and variables measured on the graphic tablet
- to analyse the correlation between personal traits evaluated by the graphologists and the results of the psychometrical tests.

With all these formulated aims, the purpose of the study is to bring additional scientific evidence of the rational background of the handwriting analysis.

[11] Bühler (1973)

4. THE EXPERIMENT

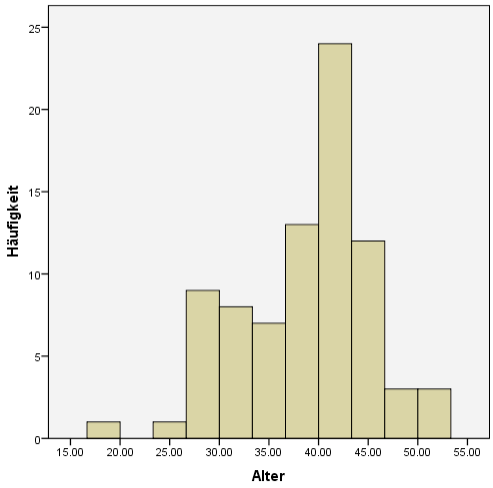
The study involves 81 probands who participated in the experiment. All of them gave handwriting samples as on the tablet as on normal paper. With the tablet's connection to a computer the data are measured and registered electronically by several parameters. Six experienced graphologists (all members of the Swiss Society of Graphology SSG) evaluated the handwriting specimens.

In addition to that, most of the participants (76) filled out a personality questionnaire with 60 items (NEO-FFI) that allows an interpretation based on the "BIG FIVE" personality factors, a category usually applied in that kind of questionnaires that evaluates items as neuroticism/emotional stability, extraversion, openness to experience, agreeableness, and conscientiousness.

Finally, all of the participants absolved the concentration test "d2" that measures the degrees of performance and concentration as well as the number of mistakes.

4.1 THE RANDOM SAMPLE

The 81 probands to accede in this study derive from the normal Swiss population. So as to get a heterogeneous distribution they were chosen from different social layers. In this study, 45 women (56%) and 36 men (44%) took part, theirs age reaching from 18 to 53 years with a mean of 39 years.



Distribution according to age

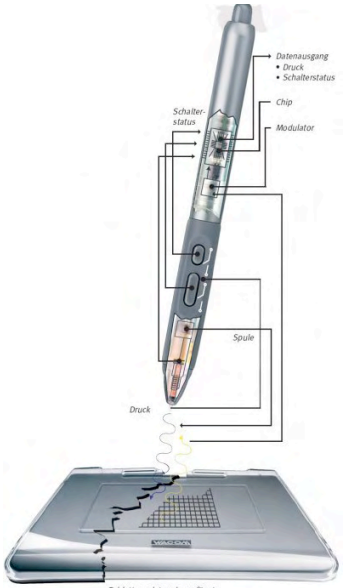
As mentioned before, the education of the participants is different:

	Number of Persons	Percent
Without indication	3	3.70
Traineeship or similar	34	41.98
Matura / Technical college / similar	15	18.52
Students of the ZHAW (Psychologies)	14	17.28
University /Academy	15	18.52
Total	81	100

4.2 THE ELECTRONIC GRAPHIC TABLET

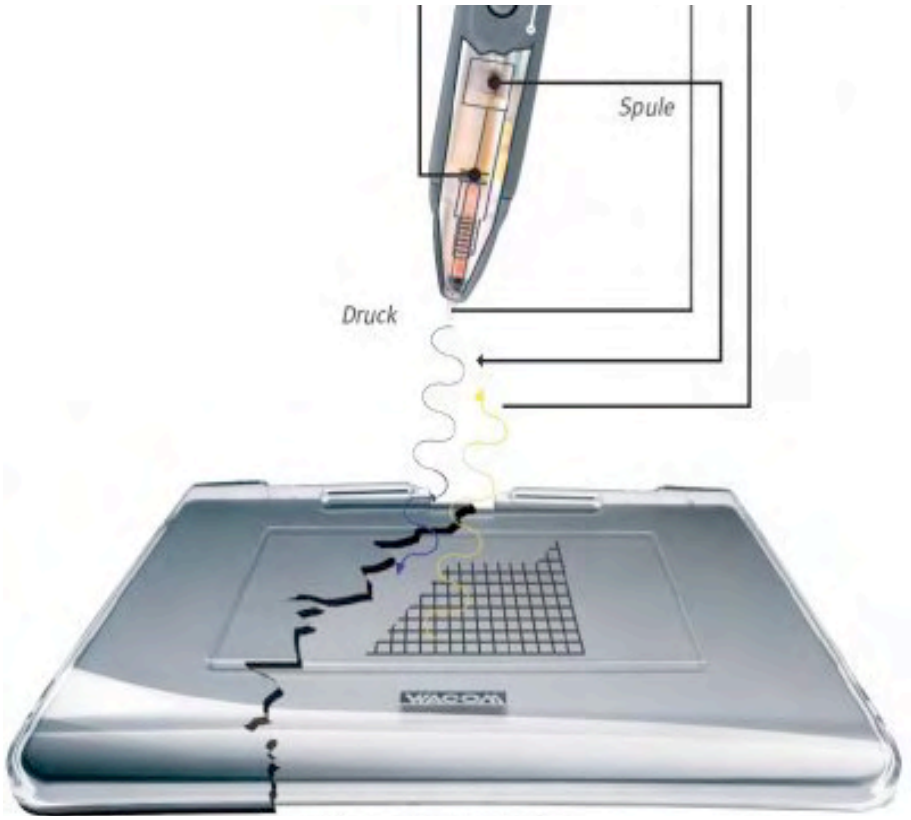
Boris Peterka carried through the experimental part of the study described in details in his Bachelor thesis.[12] He used the tablet "Wacom Intuos3 A4" together with "Intuos 3 Ink Pen" to conduct the measurements.

The Writing Tablet



The Pen

The graphic tablet contains, under the writing plate (on which a single sheet of paper is posed), a grill of fine wires to give a signal when touched by the writing pen. The pen is equipped by a ballpoint and a magnet in order to simulate a writing as normal as possible.

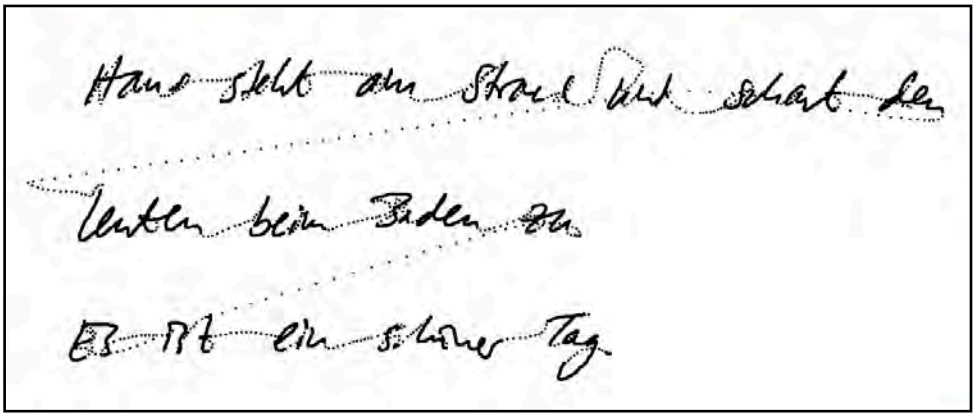


[12] Peterka (2009)

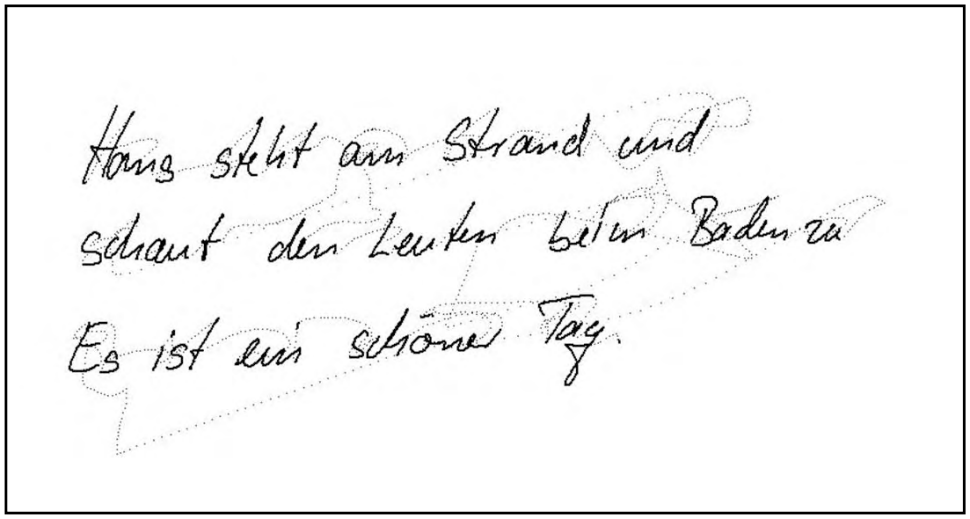
The tablet is connected to the PC equipped with a special CSWin-Program and allows the registration of the movements done both on the tablet an in the air unto a distance of 10 mm ("immaterial connections").

Label of CSWin after painting on antique greek vase (see cover)

The probands were asked to give three particular samples of normal, painstaking (later termed "slow"), and fast writing on the tablet by writing a standardized text and one sample on normal paper by writing a free text.

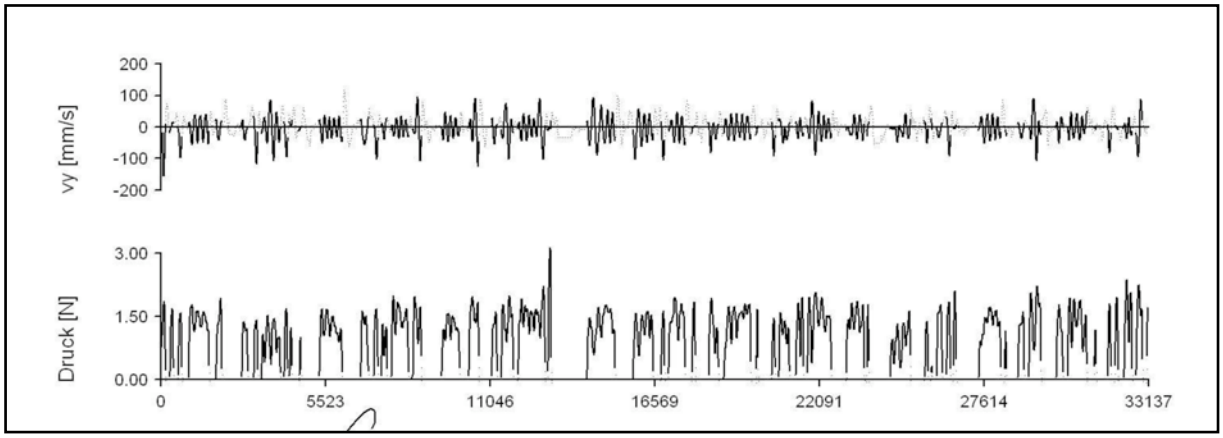


Sample of registered handwriting with visible immaterial connections:
proband with the very best results in d2 – look at the very direct connections in the air (dotted)

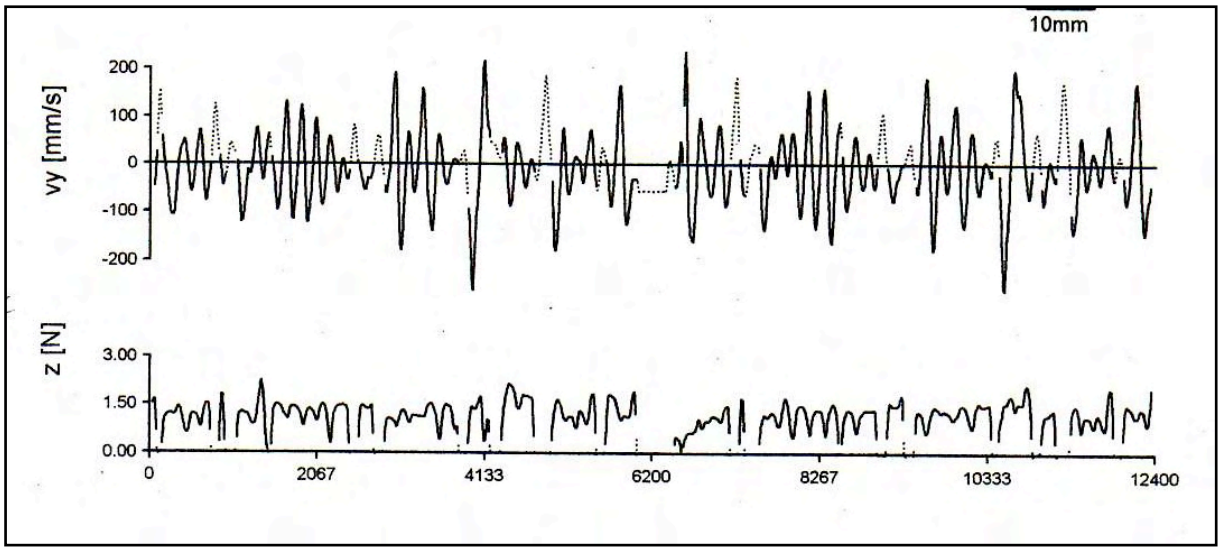


Sample of registered handwriting with excessive and deviating immaterial connections:
proband who is quick and efficient yet committing too many errors in d2

Graphs of Speed (first curve) and Pressure (second curve):



Sample with low Speed and high Pressure



Sample with high Speed and low Pressure

The 12 variables measured electronically (termed "***measured variables***") in the experimental part are the following:

No	Variable	Unit	Notation	Remarks
1	Time Total	ms	TT	Time Total was explicitly measured, however the following dependency exists: TT = TP + TA
2	Time on Paper	ms	TP	Time spent on the paper.
3	Time in Air	ms	TA	Time spent in the air.
4	Path Total	mm	PT	Path Total was explicitly measured, however the following dependency exists: PT= PP + PA
5	Path on Paper	mm	PP	Path measured on the paper.
6	Path in Air	mm	PA	Path measured in the air.
7	Movement	%	MV	Variable presents the proportion of the movements done on the paper to the movements in the air. Formally is the relation of the path on the paper to the total path: MV = PP/PT
8	Speed on Paper	mm/s	SP	Speed measured on the paper.
9	Speed in Air	mm/s	SA	Speed measured in the air.
10	Pen Touches	n	TC	Number of times the pen touched the tablet during the writing. In other word number of times, the writing on the paper was interrupted.
11	Pressure	g	PR	Pressure is measured in units of 102g.
12	Frequency	n/s	ST	Number of strokes (up and down) in second.

The 12 measured variables in the experimental part

Measurements were done for all three writing types: normal, fast and slow (painstaking). Thus, for each proband we got three measurements for each variable. The accuracy of the measurement is generally very high. However, it has its natural limitations.

4.3 A PSYCHOMETRIC TEST: d2

The d2 by Brickenkamp[13] is a concentration test based on visual stimuli, the aim of which is to demand a person's concentration performance by working quick and accurately at the same time. The proband has to complete a very monotonous task during about 5 minutes and under time pressure: There are 4 different types of d", d', p" or p' with one, two, three, or four inverted commas, either on left or right side or on the top or bottom, on 14 lines containing 47 signs. The task is to mark any d-sign with two commas, within 20 seconds per line.

The main result (concentration performance) we consider is composed by the number of correctly marked signs minus the mistakes done by confusion.

4.4 A PSYCHOMETRIC TEST: NEO-FFI

The German version of the personality questionnaire NEO-FFI[14], based on a German translation of the "NEO Five-Factor Inventory" (NEO-FFI) by Paul Costa and Robert McCrae, comprehending 60 items, is a short version of the NEO-PI-R with 240 items. We decided to choose the short version for not drawing too much upon the probands; as the questionnaire is based as well on the Five-Factor-Theory and very often used, this decision seemed to be arguable.

[13] Brickenkamp (2002)
[14] Borkenau & Ostendorf (1993)

4.4.1 Concept / Theoretical Background

The NEO-FFI is constructed upon five factors representing personality dimensions as follows:

- Neuroticism (e.g. nervous, anxious, sad, unassertive etc.)
- Extraversion (e.g. companiable, active, communicative, cheerful etc.)
- Openness to experience (e.g. inquiring, creative, imaginative etc.)
- Agreeableness (e.g. altruistic, sympathetic, appreciative etc.)
- Conscientiousness (e.g. orderly, reliable, accurate, ambitious etc.)

These five factors are robust dimensions found by observation and evaluation of individual difference. These five dimensions appear very frequently and regularly in the analyses of personality factors. In numerous studies they were replicated to a large extent and found independent of random samples, observations, instruments, methods of extraction or rotation of the factors, and culture environment.

4.4.2 Critique

The questionnaire works with raw values (column 1) to be transformed in stanine values (column 4). According to the test manual, besides the stanine value there is a true value. As shown below, in the columns 5 – 7, bilateral expectation ranges of 90%, 95%, and 99% of the true value are listed. The intervals indicate the range of the true value with probabilities of 90%, 95%, or 99%.[15] Thus, if a proband reaches a raw value of 24 this value corresponds to a stanine value of 4. Considering instead the true value, with a probability of 95%, the same proband might reach a stanine value of 2, 3, 4, or even 5. Due to this large tolerance of the test, the result appears rather at random, and we doubt if by this test we can get a realistic description of a person's character.

15	3.67	32	1	13.1–21.7	12.3–22.5	10.7–24.1
16	4.59	33	2	13.9–22.5	13.1–23.3	11.5–24.9
17	5.80	34	2	14.7–23.3	13.9–24.1	12.3–25.7
18	7.58	36	2	15.5–24.1	14.7–24.9	13.1–26.5
19	10.62	38	3	16.3–24.9	15.5–25.7	13.9–27.3
20	14.70	40	3	17.1–25.7	16.3–26.5	14.7–28.1
21	19.17	41	3	17.9–26.5	17.1–27.3	15.5–28.9
22	23.48	43	4	18.7–27.3	17.9–28.1	16.3–29.7
23	27.44	44	4	19.5–28.1	18.7–28.9	17.1–30.5
24	32.49	45	4	20.3–28.9	19.5–29.7	17.9–31.3
25	38.17	47	4	21.1–29.7	20.3–30.5	18.7–32.1
26	43.69	48	5	21.9–30.5	21.1–31.3	19.5–32.9
27	49.25	50	5	22.7–31.3	21.9–32.1	20.3–33.7
28	55.63	51	5	23.5–32.1	22.7–32.9	21.1–34.5
29	62.17	53	6	24.3–32.9	23.5–33.7	21.9–35.3
30	67.74	55	6	25.1–33.6	24.3–34.5	22.7–36.1
31	73.02	56	6	25.9–34.4	25.1–35.3	23.5–36.9

In spite of this critique, we decided to apply the NEO-FFI due to it's large prevalence and wide acceptance as well as to the easy accomplishment.

[15] Borkenau & Ostendorf (1993), p. 47ff.

4.5 GRAPHOLOGICAL ANALYSIS OF HANDWRITING SAMPLES

Graphologists analysed the text written by all probands, without knowing the measured data. For this purpose, the text written on paper was chosen for the reason that normally graphologists have to deal with that kind of handwriting, whilst the writing on the graphic tablet is slightly different by the thin pen ball and the hard support plate which does hardly allows to estimate pressure. (The legitimation for doing so is given by statistical results, see p. 18.)

All graphologists evaluated the following eight handwriting signs and eleven personal traits. The evaluated items are shown in the table below and termed "***evaluated signs***" (in German graphological literature mostly termed "single characters", left column) and "***evaluated traits***" (right column, termed normally "holistic characters": items 1, 2 according to Pfanne[16] and 11 according to Wallner[17]; the terms 3 to 7 are interpretations according to the NEO-FFI, items 8 and 9 according to Nauer[18], and 10 according to the d2).

Evaluated Signs	Remarks	Evaluated Traits	Remarks
1. Speed	Definition	1. Drive	Definition by Pfanne
2. Pressure	given by	2. Control	Definition by Pfanne
3. Pressure Variation	grapho-	3. Emotional stability[19]	Definition by NEO-FFI
4. Size	logical	4. Extraversion	Definition by NEO-FFI
5. Size Variation	theory	5. Openness to Experience	Definition by NEO-FFI
6. Width		6. Agreeableness	Definition by NEO-FFI
7. Fullness		7. Conscientiousness	Definition by NEO-FFI
8. Connectivity		8. Quantitative Resilience	Definition by Nauer
		9. Qualitative Resilience	Definition by Nauer
		10. Concentration	Definition by Brickenkamp
		11. Degree of Tension	Definition by Wallner

Graphologists used a 9-th scale for the evaluation (values 1 to 9) of signs and traits. The lower value denotes the weaker presence of a sign in the handwriting. The only exception is "Tension", for which the level was evaluated with a 6-th scale according to definition.

A written definition according to graphological theory respectively to the specification prescribed by the tests was given for each sign and each trait in order to standardize best the evaluation.

[16] Pfanne (1961)
[17] Wallner et al. (2007)
[18] Setup for and first published in Vonwil (2001)
[19] Traditionally, the factor "Neuroticism" out of the Big Five is negatively defined as lack of emotional stability. In order to give the graphologists a more coherent frame, we let them evaluate „Emotional Stability" on the given 9-th scale and then multiplied the value by -1.

5. THE STATISTICAL ANALYSIS

The analytical part of the study we executed with the help of the HSStat programming system based on the MS ACCESS database. It was designed and programmed by us especially for the statistic estimations in handwriting analysis. The data originally worked out by Boris Peterka were imported into HSStat. The later results of the graphological analyses were imported as well from the specially prepared Excel Sheets.

5.1 THE ANALYSIS OF THE ELECTRONICALLY MEASURED VARIABLES

We first analysed the original variables measured in order to verify which correlations might exist between them. The purpose was to reduce the number of variables to be used in the further analysis. If two variables strongly correlate, one of them can well represent another one in the analysis, where mostly a tendency or variability is important.

5.1.1 Measurements on Paper and in the Air

As already mentioned, we measured three parameters, namely the time of writing, the path and the speed both on the paper and in the air. For the analysis of these variables, we used the Pearson correlation coefficient. The t-value for n = 81 and the confidence level of 99% is 2.64. So, the critical value of the correlation coefficient is **R = 0.285**. That is, when r > 0.285 or r < -0.285 we can say that the correlation could be somehow significant, at least it differs from zero.

There is just an empirical rule to assume a correlation as strong. Normally, a correlation over 0.9 is considered as very high, the value between 0.7 and 0.9 as high, the value between 0.5 and 0.7 as good, and the value below 0.5 as not strong correlated although still significant.

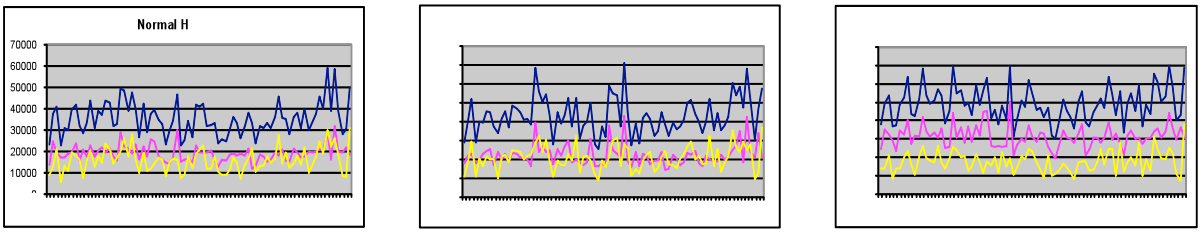
The correlation coefficients you can see in the table below. Those of them that are below the significance level we mark by red colour. Blue colour denotes values that are significant, but not high. Green colour denotes strong correlation.

Handwriting Type	Time			Path			Speed
	TT/TP	TT/TA	TP/TA	TT/TP	TT/TA	TP/TA	SP/SA
Normal	0.73	0.89	0.33	0.88	0.79	0.41	0.72
Slow	0.78	0.82	0.27	0.86	0.84	0.44	0.67
Fast	0.81	0.81	0.30	0.93	0.68	0.35	0.70

Conclusions:
The Pearson Correlation Coefficient shows a ***strong correlation between the writing in total and its components lines on paper/lines in the air,*** which allows us thereof to use in further analysis the values for total measurement.

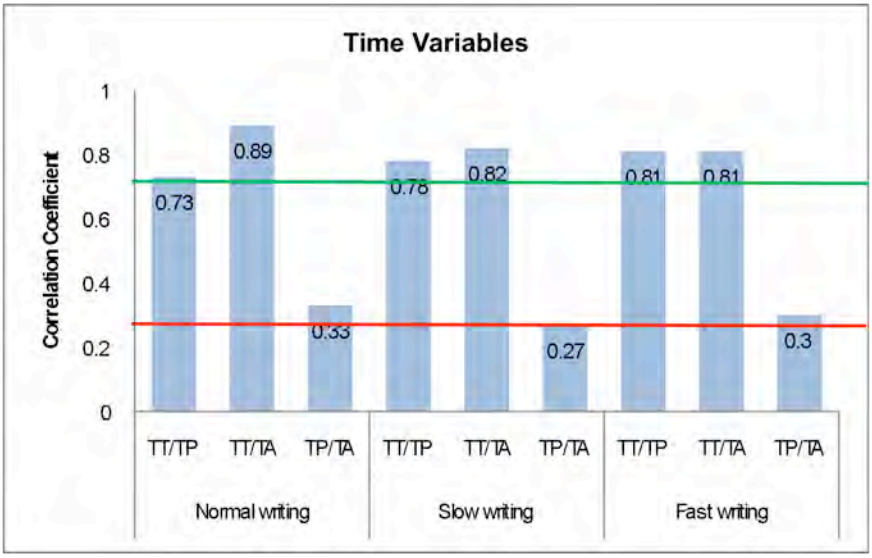
Time

The graphs below present the relationships between *Total Time* (blue line), *Time on the Paper* (red line) and *Time in the Air* (yellow line) for normal, fast and slow writing.



Congruent curves for normal, fast, and slow handwriting:
Total Time (blue line), Time on Paper (red line), Time in the Air (yellow line)

Let us show the estimated correlation coefficients graphically: The red line denotes the critical value for the correlation coefficient for the 81 measurements and the green line marks the level that denotes very high correlation.



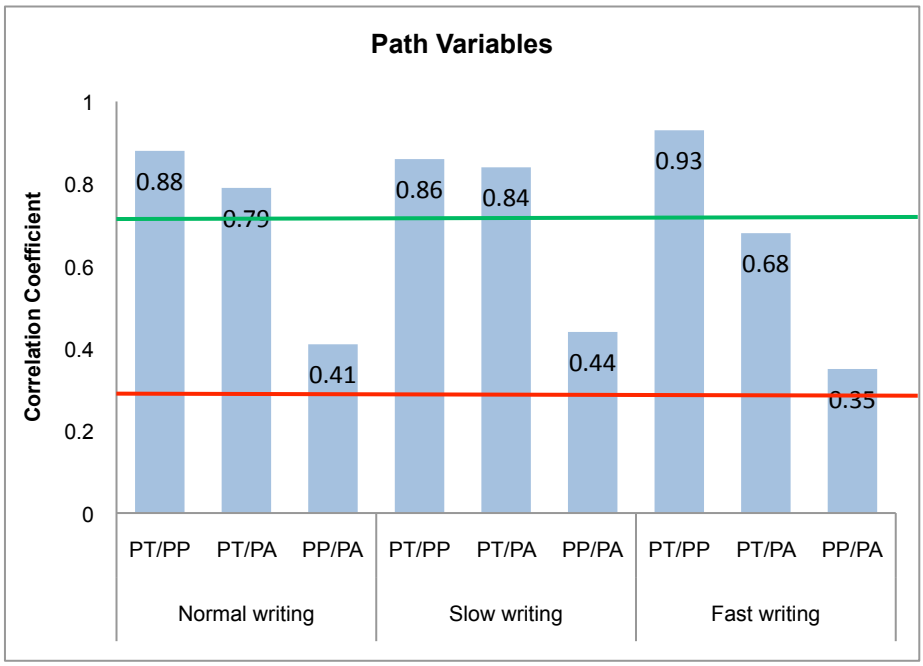
So the analysis shows that the correlation between TT and both its components TP and TA is very high. The correlation between TP and TA is over the critical value. However, it is too small to assume that a reasonable correlation exists. ***Yet, this means that in further estimations we can take just TT, since it statistically represents the time of writing with its components best of all. As well, it is important that this conclusion is correct for all three writing types.***

We will see below that sometimes the writing on the paper or in the air may have some special meaning for the interpretation. This will be to be pointed especially[20]. Generally, the total writing time will be analysed.

[20] The qualitative analysis of the invisibles (or immaterial) lines will be object of a separate investigation. Dosch (2003) was the first to deal with the very topic.

Path

Below you can see the correlation coefficients presented graphically for the *Path* variable:



The statistical relations for *Path* are very similar to those for *Time*. Again, total path PT strongly correlates with its components PP and PA. The correlation between the last ones is weak. Therefore, we will use PT in the further analyses.

Speed

The results for *Speed* are a bit different. Firstly, only *Speed on Paper* and *Speed in the Air* could be measured. Secondly, the correlation between them is strong enough. So, generally, any of them could be taken. However, since for the *Time* and for the *Path* we decided to work with the total values, it would be reasonable to build a new variable, which stronger corresponds to the total values. It should be a sort of an average between SP and SA. The weighted average answers the requirements best of all:

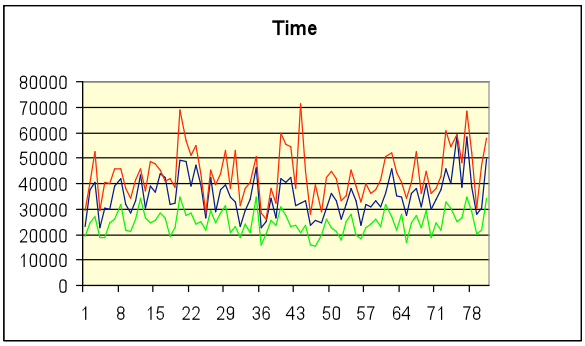
$$SW = \frac{(SP \cdot PP + SA \cdot PA)}{PP + PA}$$

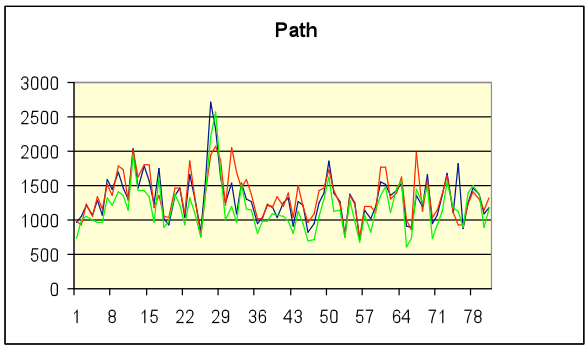
Where SW – weighted average speed

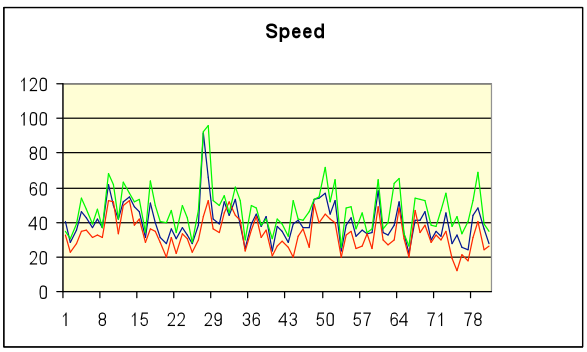
***Conclusions**: From the measurements done on the paper, in the air, and total, the total ones represent the characteristics of the handwriting best of all. For the presentation of a "total" speed, we should take the weighted value.*

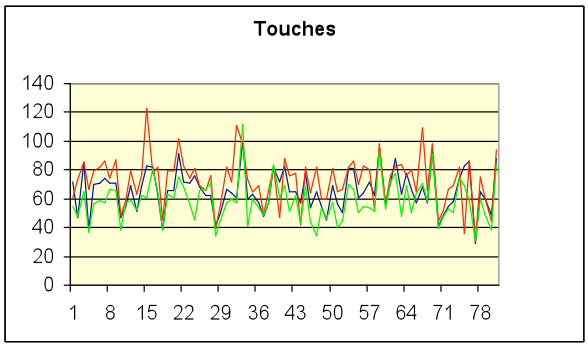
5.1.2 Normal, Fast, and Slow Writing

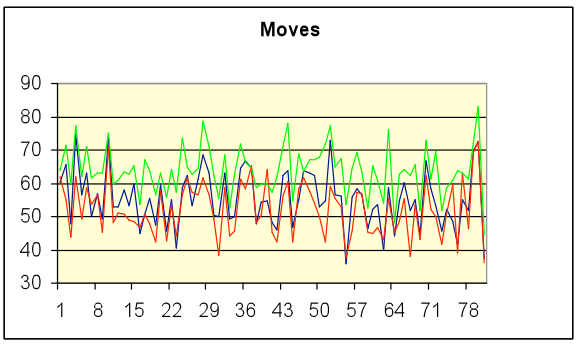
On the charts below you can see the basic data for the normal, fast and slow handwriting. The variables of normal writing are shown in blue, for fast writing in green, and for slow writing in red. On the horizontal axis probands are shown and on the vertical axis values of the measured variables.

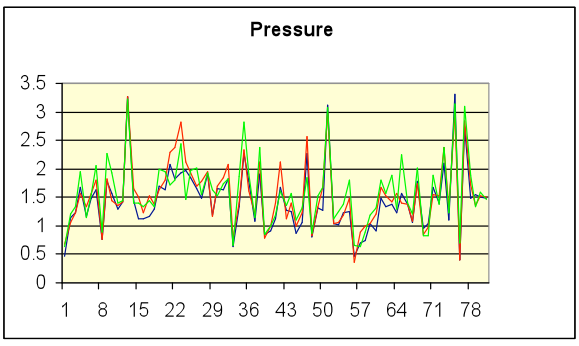


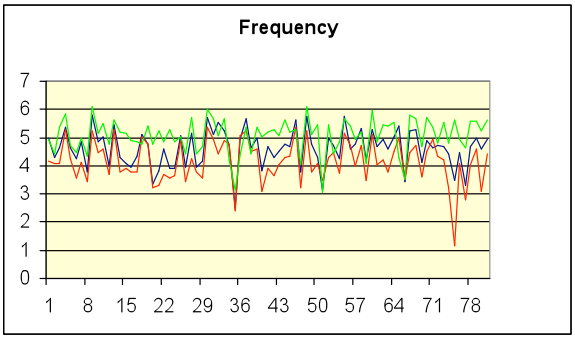












The analysis of relations between the measured variables of normal, fast, and slow handwriting was done on pairwise base. The normal handwriting was compared to the slow and the fast ones. The relation between parameters of the slow and the fast handwriting is of less interest. The normal one always takes the middle position what is clearly seen from the data. This is, as well, expected from the logical point of view.

The comparison was done with the help of the Spearman Rank Correlation and Mann-Whitney Test. It was decided to use Spearman Rank Correlation, rather than Pearson correlation since by doing that we can check whether the relation between probands remains the same in, say normal and slow handwritings. We look at their ranks and not at their values. If that is true, we can conclude that there is no matter which sample we analyse. The measured variables represent the essential qualities of the probands' handwriting: it does not matter how he writes – normal, slow, or fast. If, for instance, the path was the shortest among other probands in the normal sample, we expect it to be the shortest in the slow and in the fast samples as well. That is why the physical values were replaced with the ranks.

The interpretation of Spearman Rang Correlation is the same as of the Pearson coefficient.

By using Mann-Whitney Test we can conclude that the values of two samples are really statistically different. In Mann-Whitney physical values are taken, rather than ranks.

Variable	Normal to Slow			Normal to Fast		
	Rank Correlation	Mann-Whitney	General Relation	Rank Correlation	Mann-Whitney	General Relation
Time	0.85	5.51	N < S	0.80	8.48	N > F
Path	0.85	0.72	N < S	0.89	2.85	N > F
Speed	0.87	4.59	N > S	0.85	6.54	N < F
Touches	0.74	3.03	N < S	0.79	3.42	N > F
Movement	0.83	2.33	N > S	0.83	6.22	N > F
Pressure	0.94	1.21	N < S	0.91	1.92	N < F
Frequency	0.68	3.16	N > S	0.62	4.52	N < F

Conclusions*:** The Spearman Rank Correlation shows a ***strong correlation between the normal and slow handwritings and the normal and fast ones (with a few exceptions[21]). At the same time, the values are significantly different (Mann-Whitney Test). That means that probands really were writing in a different manner in each trial. Thus, in further explorations, ***the normal data can well represent the qualities of the probands' handwriting.***

Additionally, the high correlation level between different styles of writing of the same probands encourages us to ***assume that the handwriting samples done on the normal paper and not on the graphic tablet strongly preserve the same signs.*** It is important for the further graphological analysis because graphologists, accordingly to their daily practice, prefer to deal with the classical handwriting samples.

[21] Only by the Path the difference between normal and slow samples and by the Pressure the difference between normal, slow and fast are not significant.

5.1.3 Relations between Measured Variables

The pair relations between measured variables were investigated with the help of the Pearson correlation. The table below presents the results.

	Time	Path	Speed	Touches	Moves	Pressure	Frequency
Time	x	0.36	-0.48	0.27	-0.50	0.33	-0.63
Path	-	x	0.61	0.06	-0.13	0.23	-0.15
Speed	-	-	x	-0.19	0.33	0.03	0.33
Touches	-	-	-	x	-0.59	-0.25	-0.12
Movement	-	-	-	-	x	0.04	0.01
Pressure	-	-	-	-	-	x	-0.32
Frequency	-	-	-	-	-	-	x

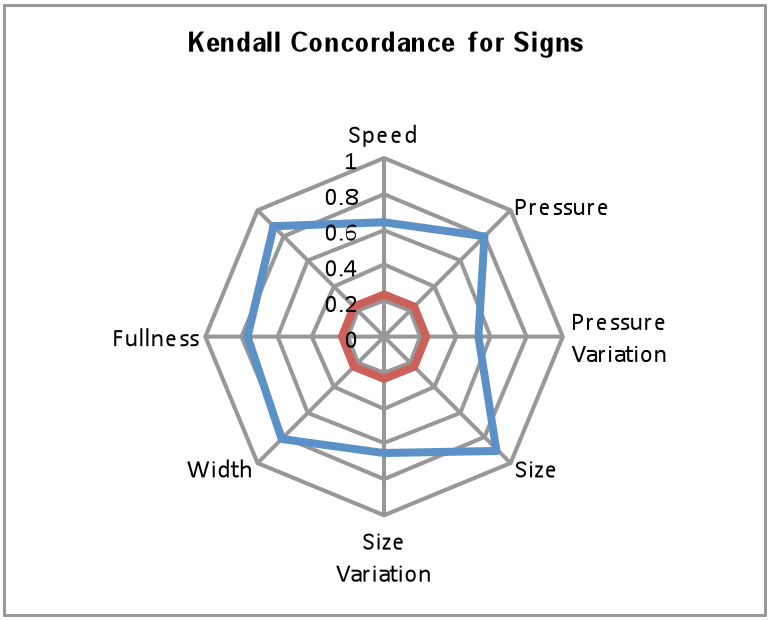
Conclusions*:** The Pearson Correlation says that there is no significant correlation between measured variables. Only three relations approach the zone of the strong correlation[22]. ***That allows us to use all of them in the further analysis, since they do not formally influence one another.

5.2. THE ANALYSIS OF THE GRAPHOLOGICAL ESTIMATIONS

5.2.1 The Concordance on Evaluated Signs

To evaluate the level of intercorrelation among the results of analyses provided by the six involved graphologists, we used the known methods for expert procedures. The Kendall concordance shows the level of agreement for multi-expert evaluation. It is based on ranking. Therefore, it shows how well experts agree with each other when they rank probands. The decisive criterion is whether the order follows the same positions.

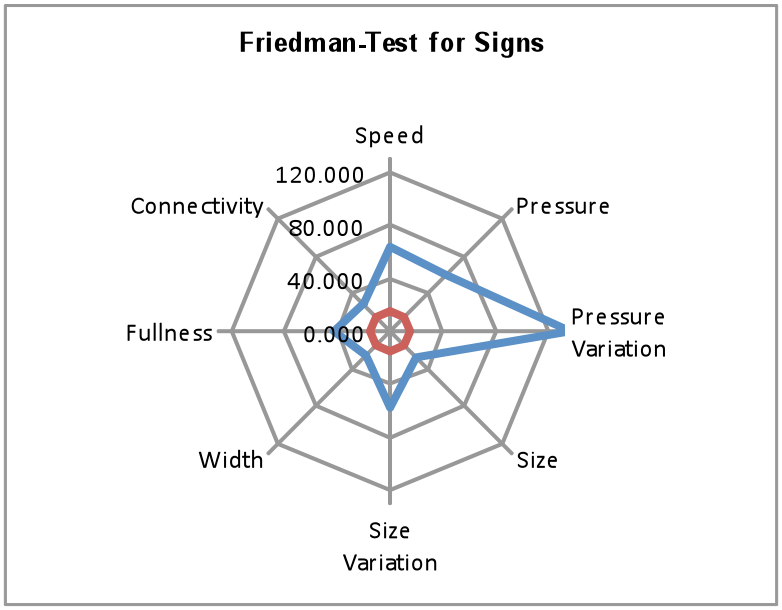
The results for handwriting signs we show on the following graph:



[22] Namely, a negative correlation between *Time* and *Frequency*, a positive correlation between *Path* and *Speed*, and a negative correlation between *Touches* and *Moves*.

The red line denotes the critical value for 81 probands and 6 experts. In order to speak of high concordance the Kendall coefficient must be higher than the critical value (red line). That is clear case for all evaluated signs. The Kendall concordance is for us of most interest.

The second criterion is the Friedman-Test. It shows how strong values given by the experts differ from each other. It's emphasis is on the values and not on the ranks of ordering. The red line denotes here as well the critical value. However, in order to conclude that there is a concordance among experts the value of Friedman's coefficient ought to be smaller than the critical value. In our case, we see that for signs that did not happen.



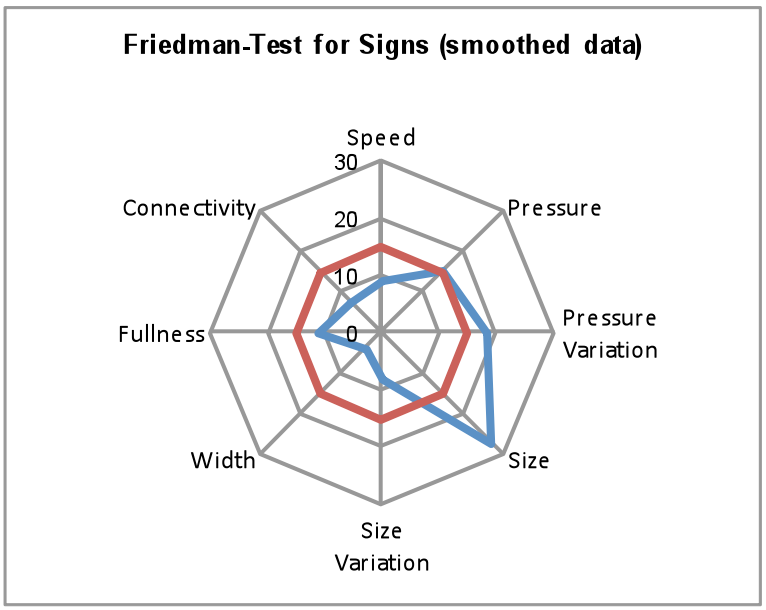
It means that experts very well agree on the ordering of the probands; however, they disagree on the ranks they assign to probands for specific signs.

Yet, the Kendall concordance is much more important for us. In spite of the given definitions, the levels given by experts are subjective. What one expert considers as very strong another assumes as average. Important is that they are consistent in their rating. The effect we discovered is that sometimes one expert tends to give either higher or lower levels for *all probands on specific sign*s.

To improve that, we have applied the following procedure of data smoothing: For every expert we performed Wilcoxon-Test, comparing his evolution to the average among the rest ones. If the difference is statistically big, we updated the ranks he had assigned for all probands. If his ranks were too high we reduced them, if too small, we increased them. We repeated that iteratively until there was room for improvement. We applied it for every sign.

With the described procedure we sometimes got the boundary problem. The rank for a particular proband was already minimal (=1) and had to be decreased further. To cope with it we recalculated originally all ranks from the 9-th into an 18-th scale by just doubling the values. After that, we updated them by one according to the described procedure. Such updates denote half a rank in the original scale.

The smoothing of the data with the described procedure does not affect correlations and the Kendall Concordance. They remain the same. However, it allowed us to strongly improve the Friedman-Test and to use the smoothed data for the further modelling. The diagram for Friedman-Test results with the smoothed data looks as follows:



We see that only for *Size* (and slightly for *Pressure Variation*) the Friedman-Test values are over the critical value. All the others are smaller. That denotes that with the smoothed data the expert evaluations are agreed by values as well. This result could be expected, since Kendall Concordance is high.

All values shown in the graphs are presented in the following table.

Signs	Kendall Concordance		Friedman-Test		
	Critical Value	Calculated Value	Critical Value	Calculated Value	Value for Smoothed Data
Speed	0.234	**0.639**	15.086	63.499	**9.190**
Pressure	0.234	**0.794**	15.086	59.758	**15.404**
Pressure Variation	0.234	**0.532**	15.086	135.492	**18.640**
Size	0.234	**0.897**	15.086	27.261	**27.261**
Size Variation	0.234	**0.649**	15.086	57.979	**8.148**
Width	0.234	**0.811**	15.086	25.970	**3.926**
Fullness	0.234	**0.767**	15.086	42.933	**11.205**
Connectivity	0.234	**0.876**	15.086	28.921	**7.674**

Conclusion: Graphologists reach a high level of concordance among them in evaluating handwriting signs.

5.2.2 Relations Between Evaluated Signs and Electronically Measured Variables

The next step of the study was to compare electronically measured variables to the signs estimated by the graphologists. The aim was to verify whether the results are close, or, to say, whether the graphologists correctly evaluate the handwriting signs. Even stronger: whether we

can expect a static graphological sign (static whilst evaluated from the written text) to adequately reflect a certain physical parameter, which is dynamic while measured during the process of being written.

We investigated the correlation between evaluated signs and the corresponding measured variables. It is well known that the analysis of handwriting works fine for some specimens and worse for others. On the other hand, every point which strongly stands out from a tendency, can influence the statistical analysis when the number of points is not very big. In our case we have 81 probands, which is, for mathematical statistics, not too many. That means that any single "outstanding" point can influence strongly enough. Yet, indeed, we are interested in the tendency. To avoid such inadequate influence we have worked out a special procedure that allowed us to ignore some outstanding points in the allocation, but not more than 6-8, that is, not more than 10%. This procedure - which is usually applied accordingly to fair consideration - was used not only for the analysis of the relations measured variables/evaluated signs, but also for the later analysis of evaluated traits and psychometrical tests. We as well saw that for many relations the same specimens (or probands) are "trouble-makers" distorting the reasonable interpretation, so the appliance of the mentioned procedure seems quite correct.

To study the relation between measured variables and evaluated signs we took their average ranks transformed into relative values by dividing by 18. That is, they vary from 0 to 1. Besides investigating correlations, we constructed simple linear regression models for signs. In these models measured variables are input (we took them as well in relative form by dividing by the maximal value of the variable), level of signs is output. The models show how good the approximation is, when we try to build the evaluated sign level from the measured variables.

The regression models

Based on the results of the correlation analysis we built regression models. The aim of a model is to present the evaluated signs as functions of the measured variables. At first we normalised both so that they are presented on the scale from 0 to 1. The model form is linear. That is the most rational model for high correlated factors. Let us denote an evaluated sign through y (that is, e.g. the evaluated sign Speed) and a measured variable through x (that is, e.g., the measured variable Speed). Then the model looks as follows:

$$y = ax + b$$

So we get a new measured value x and insert it in the model; hence we can – approximately of course - estimate the expected value for the evaluated sign. However, for this the parameters a and b must be calculated. That was done based on our data for 81 probands, using the standard least squares method.

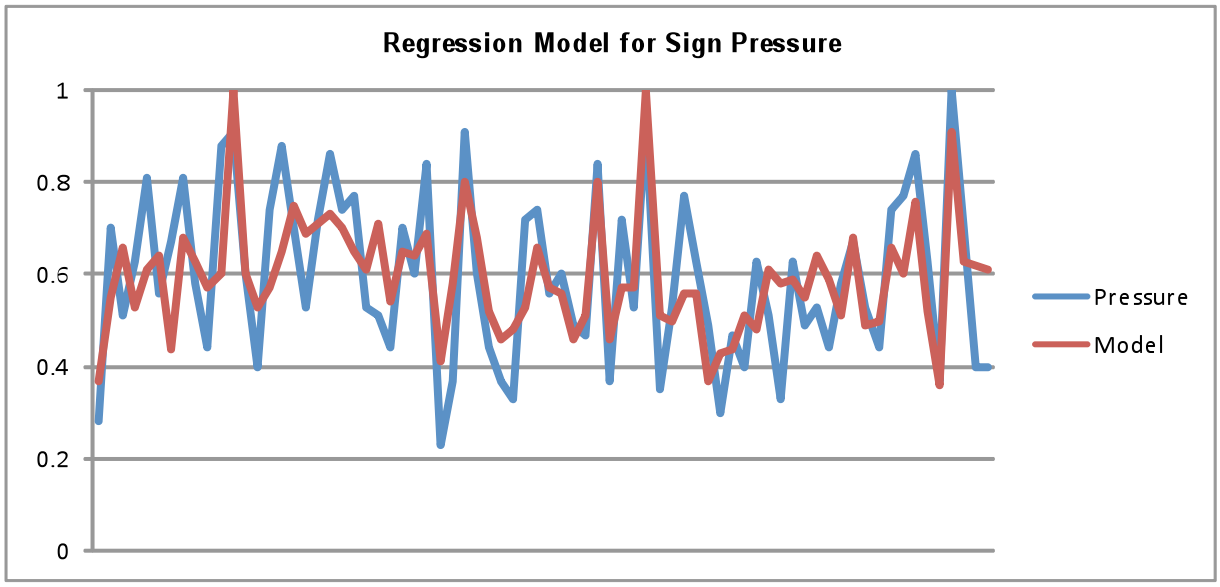
The regression model results are presented in the graph below: on the x-axis there are probands, on the y-axis the normalised values of both estimated level of the evaluated sign Speed and the modelled values. We can see that the tendency is generally well modelled. There are several points with wide differences. Yet, in general, it looks satisfactory, especially when assuming the very random character of the modelling area.

Speed

For the measured variable Speed high correlations were found to the evaluated sign Speed (**0.563**) and negative correlation to the measured variable Time (**-0.600**). That seems quite logical.

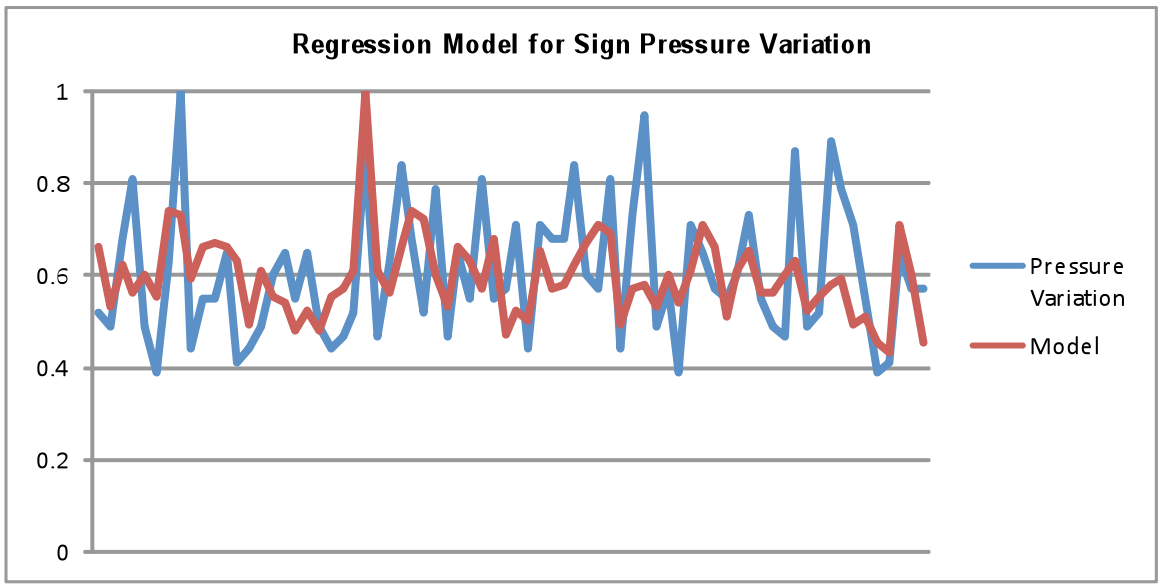
Pressure

The measured variable Pressure is mostly correlated with the evaluated sign Pressure (**0.725**). That was expected as well.



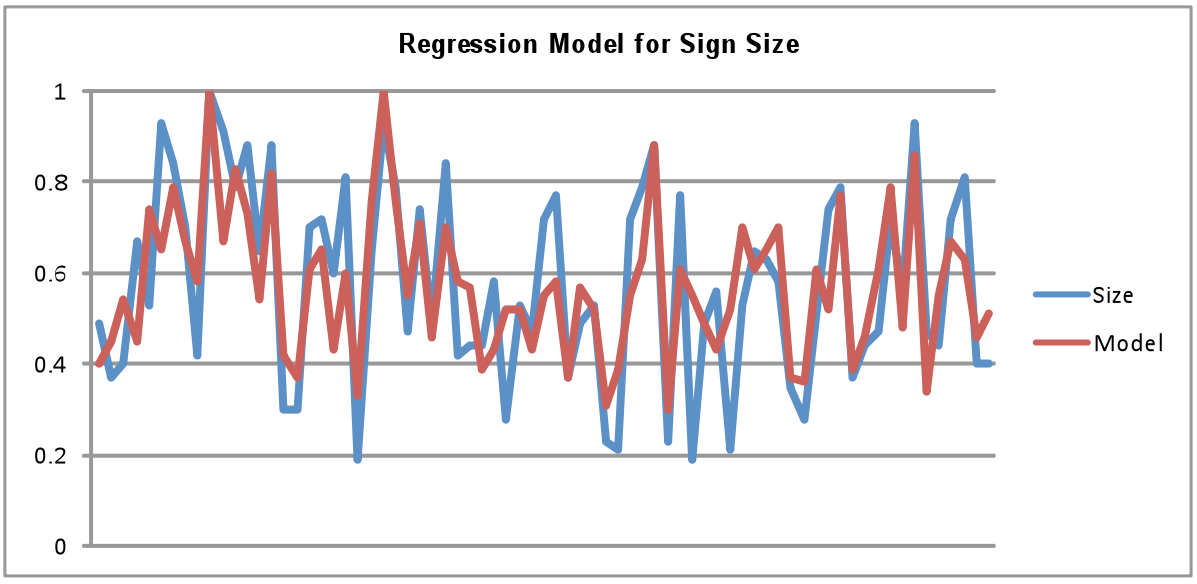
Pressure Variation

The evaluated sign Pressure Variation has the strongest correlation to the measured variable Speed (**0.415**). The value is not very high, however it shows the reasonable relation.



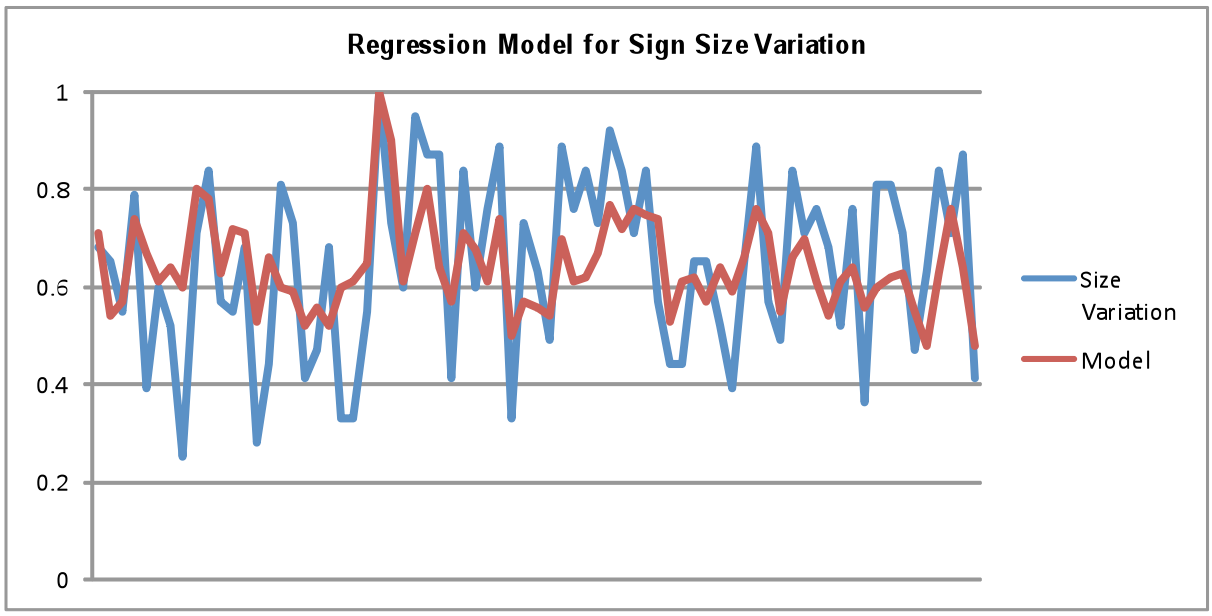
Size

The evaluated sign Size is strongly correlated with the measured variable Path (**0.782**). If we look at the Path on Paper only, then the correlation coefficient is even higher: **0.829**. This result looks very logical.



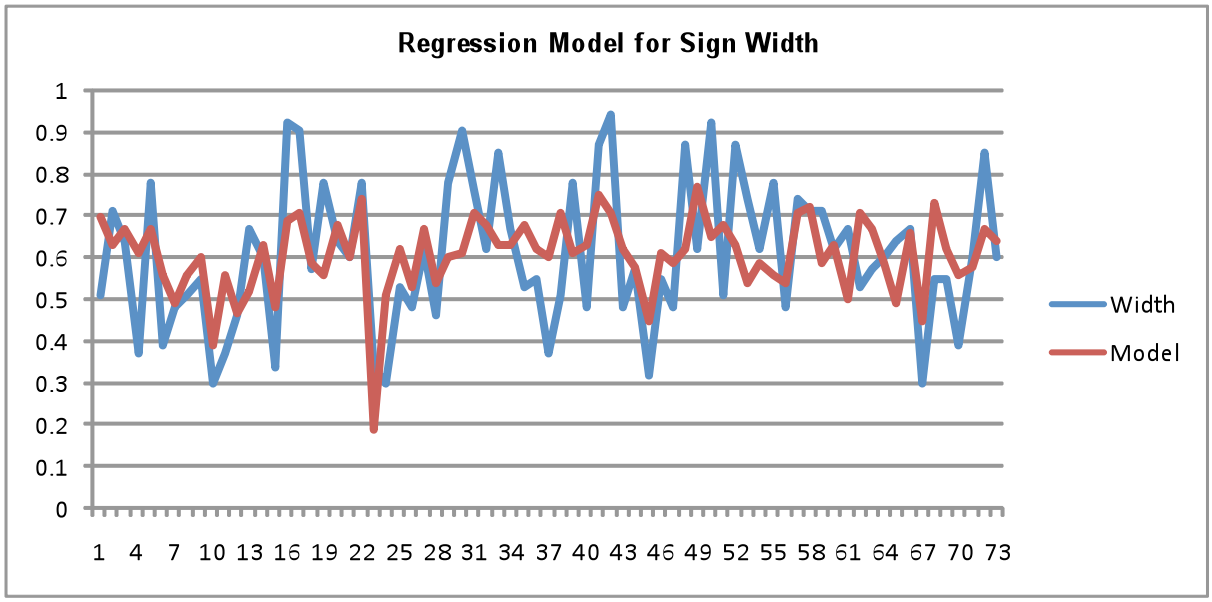
Size Variation

The evaluated signs Size Variation as well as Pressure Variation correlate mostly with the measured variable Speed (**0.542**). The faster a proband writes, the stronger are the variations in his handwriting.



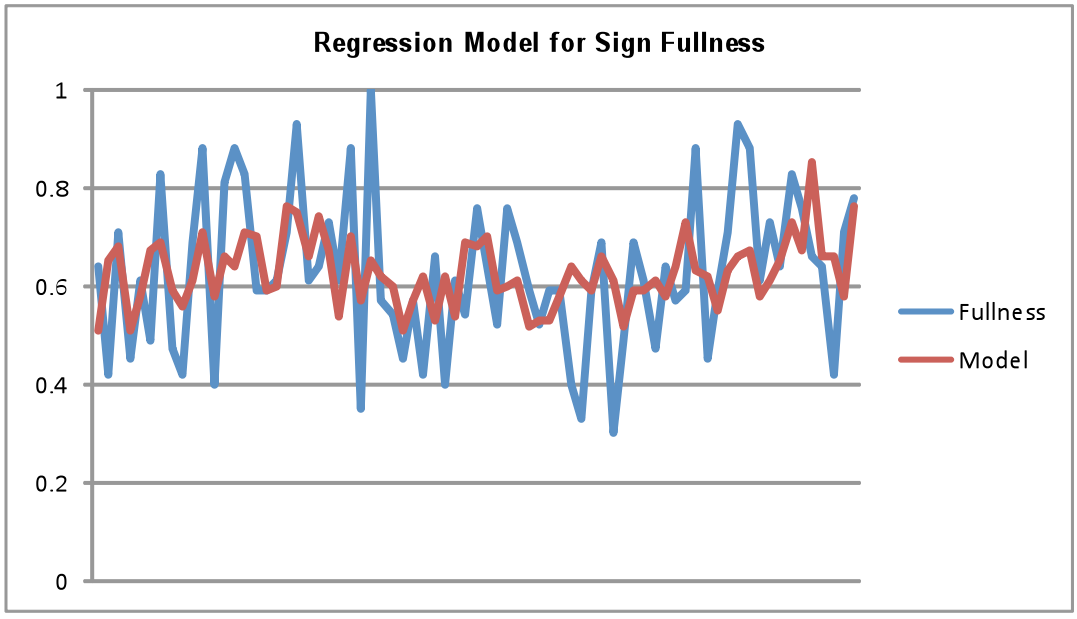
Width

The evaluated sign Width has a significant negative correlation with the measured variable Path (**-0.526**). At first sight this looks contradictive. We expect bigger and wider letters, when it is generally more written. However, we should not forget, that Width in graphology is not comprehended independently, but is taken in its relation to Size. And typically big letters appear tighter. The evaluated sign Size is strongly correlated to Path. That is why negative correlation between Width and Path can be well understood.



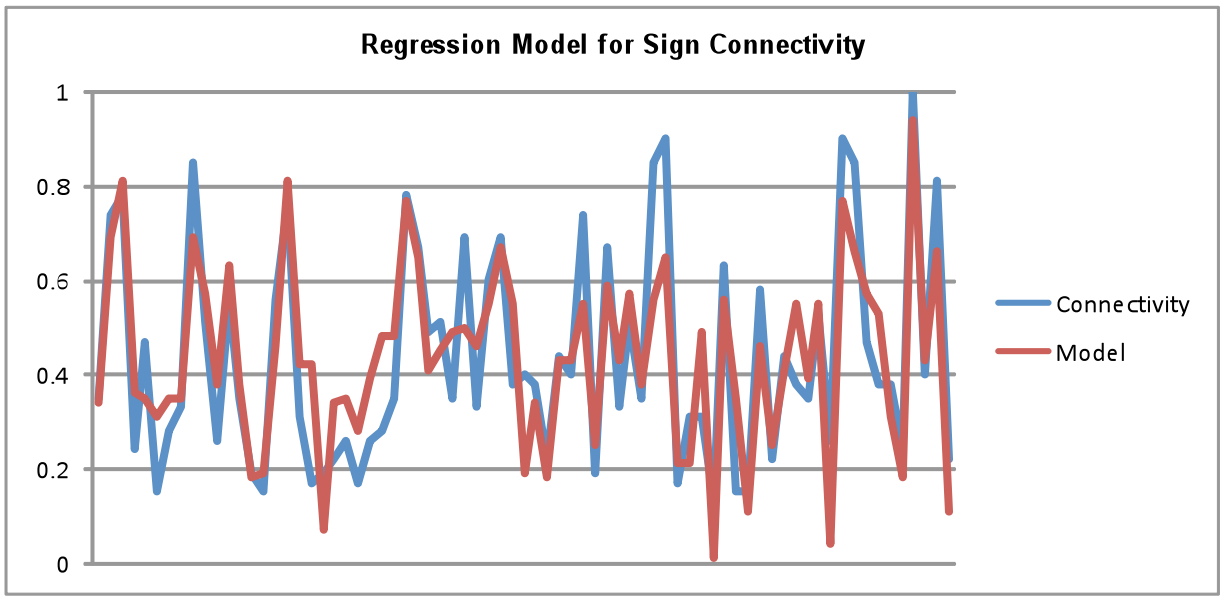
Fullness

The evaluated sign Fullness has a moderate correlation to the measured variable Time (**0.454**). We can assume probands need more time when writing full letters.



Connectivity

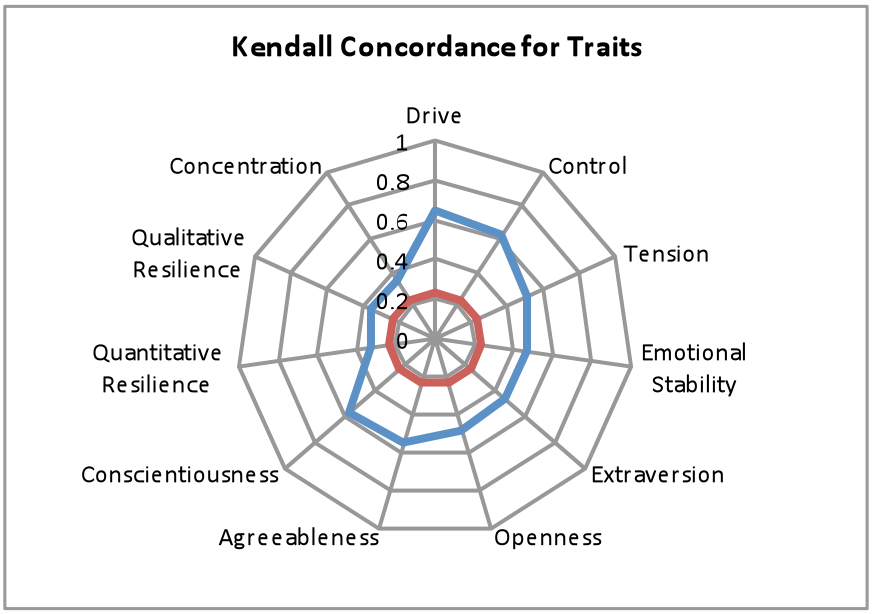
The evaluated sign Connectivity shows a strong negative correlation to the measured variable Touches **(-0.856**) and a positive correlation to the measured variable Movement (**0.668**). These findings can both be well explained. For connected writing probands use less pen touches. Every such touch denotes a disconnection. The more the person remains on the paper, the more connected is his writing. Both reasons are more or less the same, just from different perspectives.



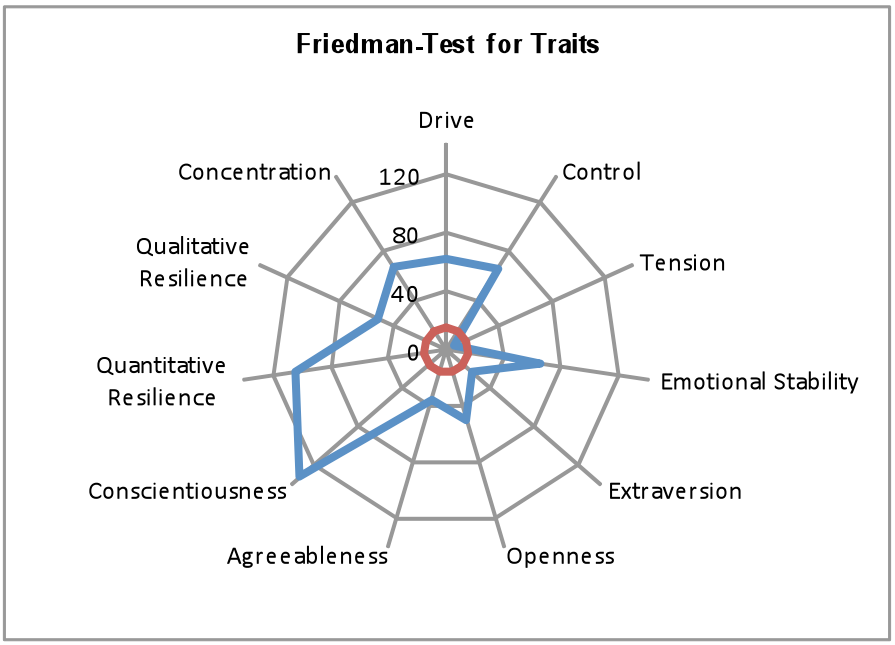
Conclusion: The conducted analysis shows that the handwriting signs evaluated by graphologists correspond well to the measured variables. They adequately reflect the dynamic aspects of writing.

5.2.3 The Concordance on Personal Traits

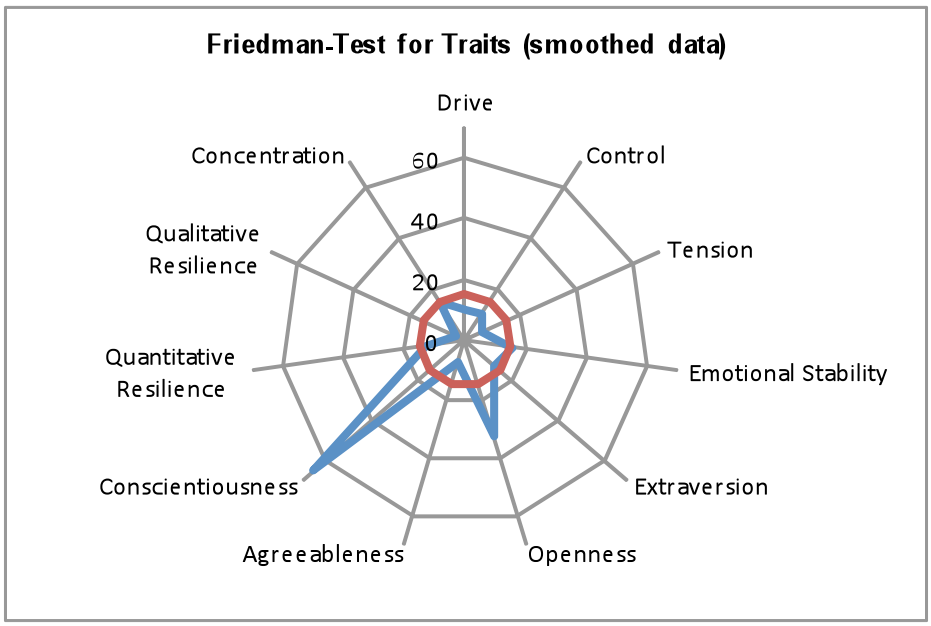
The concordance for the evaluated traits looks very alike to that one for the evaluated signs. Kendall Coefficient is significant for all involved traits.



The Friedman-Test for the original data:



The Friedman-Test for the smoothed data[23]:



We see that only for Conscientiousness (and slightly for Openness) the Friedman-Test value is over the critical one. All others are smaller. That denotes that with the smoothed data the expert evaluations are agreed by values as well. This result could be expected as well, since Kendall Concordance is high.

Conclusion: Graphologists reach a high level of concordance among them also in evaluating personal traits.

5.3 Relations Between Results of Psychometrical Tests and other Variables both Measured and Evaluated

5.3.1 The d2 Concentration Test

The analysis was based like for the NEO-FFI test on the calculation of the Spearman Rank Correlation. Correlations between the concentration performance value as major result of d2-Test and involved evaluated traits (including concentration), evaluated signs and measured variables have been calculated. Generally, they were under the significance level. Only the correlation to measured variable Time in the Air was higher (-0.262). It is still not very high, however at least exceeds the critical level. The interpretation is that people who write quicker in the air when connecting letters and who go directly from one word to another are more concentrated: They have shown better results in d2-Test[24](see example on page 9).

Conclusion: Short and direct connections in the air correlate with better results in the d2-concentration test.

[23] The procedure is according to the explanation in chapter 5.2.1 The Concordance on Evaluated Signs, p. 20
[24] This result is congruent with the findings of Peterka (2009)

5.3.2 The NEO-FFI Five Factory Inventory

The analysis was mainly concentrated on Spearman Rank Correlation between the results of the NEO-FFI test and the evaluation for the corresponding traits done by the graphological analysis (yet also on the correlations between NEO-FFI and all the other measured and evaluated data). Since the concordance among graphologists is high, we took just the average ranks. Generally the correlation was not extremely strong, however good enough to conclude that both came to close results. In some cases, the best correlation was not between a NEO-Five factor and the trait with the same name, but rather with other traits. It can be well explained, because the real psychological meaning of traits, evaluated by the graphologists, is close to the traditional interpretation and differs from rather specific definitions in the NEO-Five that are held, as explained before[25], rather vague and comprehending a wide and indefinite range, whilst graphologists are used to describe personal traits very accurately.

If we look, e.g., at the definition for Conscientiousness given by the NEO-FFI-Manual we see that the dimension Conscientiousness contains a large variation of personal characteristics, which graphologists never would put together in one dimension but which they are used to highly differentiate, as being assiduous, persistent, systematic, strong-minded, disciplined, reliable, solid, punctual, orderly, accurate, pain-staking; but also being capable for activity, planning, organisation, accomplishment, purposefulness. Thus, the definition of this dimension is rather vague, and the personal estimation of a graphologist may easily accentuate more one or another characteristic.

The graphologists are able to well differentiate if an author of a handwriting would rather be more orderly and accurate, or rather ambitious and purposeful – characteristics quite different and important that may but must not go stringently together in one person; they are, in the contrary, rather not expected to be found often in one and the same sample of handwriting, and they correspond, when clearly marked, to different types of candidates e.g. in personnel selection.

The dimension Openness lies, as far as the definition goes, pretty near the dimension Extraversion and shows similar difficulties of evaluation as the dimension just discussed. Similar problems arouse when evaluating the other factors. Nevertheless, the Spearman Rank Correlation shows a ***high congruence between three of the factors evaluated by the graphologists with the NEO-FFI results (Openness, Agreeableness, Conscientiousness).***

Neuroticism[26]

The NEO-FFI factor Neuroticism shows a negative correlation with the evaluated trait Drive (-0.471) and a weak correlation with the evaluated sign Connectivity. There is no correlation with the like-named evaluated trait.[27]

Yet, the two positive correlations make sense from the graphological point of view: a person not very assertive does not dare to go forth very straight and is cautiously and circumspectly finding her way by not interrupting her path neither on the paper.

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[25] See critique on p. 12

[26] Traditionally, this one factor out of the Big Five's is negatively defined as lack of emotional stability. In order to give the graphologists a more coherent frame, we let them evaluate „Emotional Stability" on the given 9-th scale and then multiplied the value by -1.

[27] Lavoie (2006) however found a good correlation in Emotional Stability with the 16PF Test.

As to evaluate emotional stability or lability (neuroticism) there might be some difficulty due to the dimension's definition be it either in the NEO-FFI or in the graphologists' personal view. It might be interesting to follow up and improve the very problem.

Extraversion

The NEO-FFI factor Extraversion has no correlation with the like-named evaluated trait although previous authors found some especially in this very factor and none in others[28]. However, it is correlated well with the evaluated trait Drive (0.402) and the evaluated trait Tension (0.417) as well as negatively correlated with the evaluated trait Agreeableness (-0.494).

On the level of psychological and graphological interpretation we may say as well that this makes sense, because a person described in general as extraverted shows a clearly marked drive and a good tension in his handwriting, while he or she does not care much about being agreeable.

Openness for Experience

The NEO-FFI factor Openness for Experience correlates with the like-named evaluated trait (0.488)

Although above we mentioned some difficulties concerning the exact definition of this dimension by the NEO-FFI, we have a good correlation what may encourage graphologists to interprete directly this dimension from any handwriting.

Further, we find weak correlations with measured variables: a negative one with Time (-0.306), positive ones with Speed (0.276) and Frequency (0.293).

This is to say that a person who is open to new experience seems in general to be more quick and fast in moving.

Agreeableness

The NEO-FFI factor Agreeableness has the strongest negative correlation to the evaluated trait Tension (-0.432), correlating at the same time with the like-named evaluated trait Agreeableness. The value (0.273) is over the significance level, yet not very high.

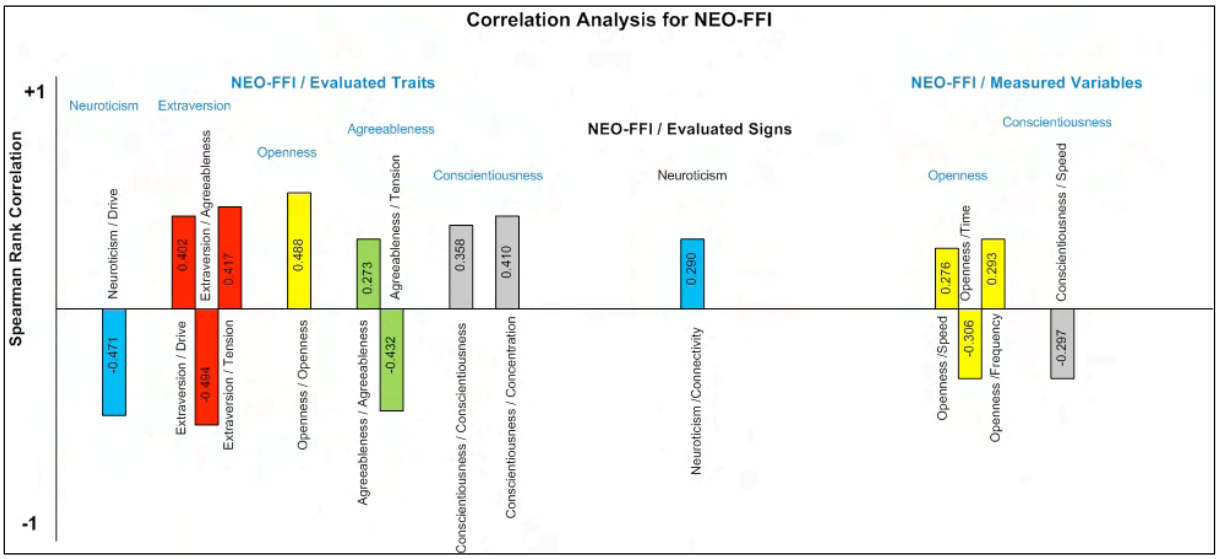
Graphologically we can say that this makes sense: a very agreeable person will not appear very tense, but tends to rather empathize smoothly.

Conscientiousness

The NEO-FFI factor Conscientiousness correlates with the same evaluated trait pretty good (0.358) and also with the evaluated trait Concentration (0.410), what makes sense according to the definition of the NEO-FFI factor Conscientiousness discussed above.

The measured variable Speed correlates slightly negatively (-0.297), because you cannot be very fast when accurately concentrating to a difficult task.

[28] Bergonzi (1974), Urbani (2006)



Conclusions: As far as the graphologists' evaluations, probands with higher values in Neuroticism write with more connections and less drive; the more extraverted probands write with more drive and higher tension whilst they do not care about being agreeable; the agreeable ones show less tension, and the conscientious ones are more concentrated.

Open participants write objectively with more speed in little time and with high frequency; the conscientious ones write with less speed.

In spite of some difficulties due to the definition of the NEO-FFI factors concerning the graphological evaluation, we found some - yet not too many - good correlations; indeed, they all make sense from the point of view of graphological theory.

6. Summary of Findings

We summarize our findings from our analyses as follows:

1. There is a strong correlation between the writing in total and its components lines on paper/lines in the air.
2. There is a strong correlation between the normal and slow handwritings and the normal and fast ones. At the same time, the values are significantly different. That means that the probands really were writing in a different manner in each trial.
3. There is no significant correlation between measured variables. This means they do not formally influence one another and may therefore be used in further analysis.
4. Graphologists reach a high level of concordance in evaluating handwriting signs.
5. The statstical analysis shows that the signs of handwriting evaluated by graphologists correspond well to the measured variables.
6. Graphologists reach a high level of concordance in evaluating personal traits as well.
7. Short and direct connections in the air correlate with better performance in the d2-concentration-test.
8. NEO-FFI: In spite of some difficulties due to the definition of the NEO-FFI factors concerning the graphological evaluation, we found some good correlations; indeed, they all make sense from the point of view of graphological theory.

There are, of course, several questions remaining open. Of special interest there will be a further evaluating of the meaning of the invisible lines in the air, the "immaterial lines", including a refined qualitative analysis of the latter, but also to involve further holistic characters often used in graphological theory and practice. All these questions may be object of a subsequent investigation by means of the electronic graphic tablet.

7. Bibliography

Aldorisio, Prospero (1611): Idengraphicus nuntius. Napoli.

Baldo (Baldi), Camillo (1622) : Trattato come da una lettera missiva si conoscano la natura e qualità dello scrittore. Carpi.

Ben-Shakhar, G., **Bar-Hillel**, M., **Bilu**, Y., **Ben-Abba**, E., & **Flug**, A. (1986a). Can graphology predict occupational success? Two empirical studies and some methodological ruminations. *Journal of Applied Psychology,* **71**, 4, 645-653.

Bühler, Kristin (1973): Die Bedeutung der elektronischen Drucksonde für die Graphometrie. Zeitschrift für Menschenkunde, 1/2, 66-77.

Bergonzi, Robert A. (1974): Die Extraversion im Fragebogen und in der Handschrift. Eine korrelationsstatistische Untersuchung. Zeitschrift für Menschenkunde, 38, 2, 297-306.

Borkenau, Peter & **Ostendorf**, Fritz (1993): NEO-Fünf-Faktoren Inventar (NEO-FFI). Handanweisung. Göttingen.

Brickenkamp, R. (2002): Test d2 Aufmerksamkeits-Belastungs-Test. (Überarb. und neu normierte 9. Aufl.) Hogrefe, Göttingen.

Bürgi, Andreas (1990): Gedanken zu einer wissenschaftlichen Fundierung der Graphologie. Zeitschrift für Menschenkunde, 54, 2, 70-90.

Burns-Birlin, Angelika (1999): Graphologische Aussagen im Vergleich mit computerunterstützten Persönlichkeitsprofilen (INSIGHTS). ZfM 63, 1/1999

Buser, Peter ((1996): Themen und Formen der graphologischen Diskussion und Forschung. Stichprobe der deutschsprachigen Literatur von 1953 bis 1995 unter besonderer Berücksichtigung schweizerischer Arbeiten. Aktuelle Forschungsfelder und Projektideen. Diplomarbeit SGG, Zürich.

Corder, G.W. & **Foreman**, D. I. (1972): Nonparametric Statistics for Non-Statistician. John Wiley & Sons, New Jersey.

Dombrowski, Daniela & **Faber**, Pascal (1998): Graphologie in der Personalauslese – Anwendung und Forschung. Zeitschrift für Schriftpsychologie und Schriftvergleichung 2/2000.

Dosch, Esther (2003): Die unsichtbare Schrift. Zeitschrift für Schriftpsychologie und Schriftvergleichung 4/2003

Guthke, Jürgen, **Beckmann**, Jens F. & **Schmidt**, Gabriele (2002): Ist an der Graphologie doch etwas dran? Untersuchungen zur Übereinstimmung von Graphologenurteil und psychometrischen Persönlichkeitstests. Zeitschrift für Personalpsychologie, 1 (4), 171-176.

Huarte, Juan de San Juan (1575): Examen de ingenios para las sciencias. Baeza.

Goldscheider, A. ((1892): Zur Physiologie und Pathologie der Handschrift. In: Archiv für Psychiatrie, Bd. 24.

Lockowandt, Oskar (1973): Der Prozess der Urteilsbildung in der Schriftpsychologie. Zeitschrift für Menschenkunde, 3.

Lockowandt, Oskar . (Hrsg.) (1988): Bielefelder Graphologische Bibliographie, Bielefeld.

Nauer, Marie Anne (1998). Assessment Center versus Graphologie. In: io-management 4, S. 42-45.

Nauer, Marie Anne (1998). Assessment Center versus Graphologie in der Diagnostik von Führungspotential. Vortrag am Graphologischen Kongress, Universität Zürich, 16./17.Oktober 1998. Zeitschrift fu r Schriftpsychologie und Schriftvergleichung 2000:2/00.

Nauer, Marie Anne & **Bürgi**, Andreas (2000). Die wissenschaftliche Graphologie in der Schweiz und Forschung heute. In: 50 Jahre Schweizerische Graphologische Gesellschaft 1950-2000. Hrsg. Urs Imoberdorf. Zürich.

Nauer, Marie Anne (2001). Assessment Center versus oder mit Graphologie? Vortrag am Graphologischen Kongress, Universität Zürich, 19./20. Oktober 2001. Zeitschrift für Schriftpsychologie und Schriftvergleichung 2002: 4/02.

Nauer, Marie Anne (2001). Assessment Centre versus Graphology. Graphology 56 (Iss. By The British Academy of Graphology)

Nauer, Marie Anne (2002). Graphologie et Assessment Center. (Contribution au Congrès International de Graphologie, Paris 11 et 12 janvier 2002.) La graphologie 2003: no. 250.

Nauer, Marie Anne (2003). Ein polarer Zuordnungsversuch aufgrund der Beurteilung von zwei Handschriften durch zwanzig Graphologen. Zeitschrift für Schriftpsychologie und Schriftvergleichung 2003: 2/03.

Nauer, Marie Anne (2003). Polarer Zuordnungsversuch zum Zweiten: Systematische Beurteilung von zwei Handschriften durch 13 Graphologen. Zeitschrift für Schriftpsychologie und Schriftvergleichung 2004: 3/04).

Nauer, Marie Anne (2005). Ricerca empirica come base di una grafologia valida nel futuro: Nuovi risultati. Conferenza al 1° Congresso internazionale di Grafologia Città di Milano 21/22 maggio 2005. In: Atti del Congresso, Roma 2005.

Nauer, Marie Anne (2006). Congruence Validity between Assessment Centre Reports and Handwriting Analyses. A Third Investigation by Polarity Profile. www.adeg-europe.eu.

Nevo, Baruch (1988). Yes, graphology can predict occupational success: rejoinder to Ben-Shakhar et al.. *Perceptual and Motor Skills,* **66**, 92-94.

Nevo, Baruch & Benitta, Rachel (1993): Rank-Ordered Matching – Validity Studies Utilising Qualitative Data: A Proposed Model and Some Empirical Results. *Australian Journal of Psychology*, Vol. 45, No.3, 131-133.

Peterka, Boris (2009): Tempo und Sorgfalt in der Handschrift, eine computerunterstützte Studie. Bachelorarbeit ZHAW, Zürich

Pfanne, Heinrich (1961): Lehrbuch der Graphologie. Psychodiagnostik aufgrund graphischer Komplexe. De Gruyter, Berlin.

Pophal, Rudolf (1949). Die Handschrift als Gehirnschrift. Rudolstadt.

Rafaeli, A., & **Drory**, A. (1988). Graphological assessments for personnel selection: concerns and suggestions for research. *Perceptual and Motor Skills.* **66,** 743-759.

Rasch, Wolf-Dietrich (1957): Hat sich die Graphologie bewährt? Bern.

Saudek, Robert (1929): Experimentelle Graphologie. Berlin.

Schmidt, Gabriele & **Dosch**, Esther (2010): Dunkelschrift-Studie. Handschriftveränderungen beim Schreiben ohne visuelle Kontrolle. *Schriftpsychologie*, Sondernummer Punktum, SBA**P.** Zürich

Schuler, Heinz und **Moser**, Klaus (1995): Die Validität des Multimodalen Interviews. Zeitschrift für Arbeits- u. Organisationspsychologie 39, 1, 2-12.

Stein Lewinson, Thea (1974): Das Handschrift-Messungs-Gerät. Zeitschrift für Menschenkunde 38, 2.

Steinwachs, Friedrich (1952): Die verfeinerte mechanische Schriftwaage. Apparatives und Methodisches zur exakten Erfassung der Psychomotorik. Archiv für Psychiatrie und Zeitschrift Neurologie, Bd. 187, 521-536.

Tschegolev Ilja, **Chernov** Yury (2008): Die Graphologie des 21. Jahrhunderts. „Piter", Sankt Petersburg.
Илья **Щеголев**, Юрий **Чернов** (2008): Графология XXI века. «Питер», Санкт-Петербург, 2008.

Tschegolev Ilja, **Chernov** Yury (2008): Die Handschrift deuten. „Eksmo", Moskau
Илья **Щеголев**, Юрий **Чернов** (2008): Тайны почерка. «Эксмо», Москва, 2008.

Urbani, Paola et. al. (2006): Graphological Analysis and Eysencks EPI Test. www.adeg-europe.eu

Vonwil, Patrick (2001): Zur Diagnostik der Belastbarkeit. Eine theoretische Konzeptualisierung und eine empirische Annäherung an die Diagnostik der Belastbarkeit am Beispiel einer Untersuchung zur Graphologie in der Pilotenselektion. Diplomarbeit an der Hochschule für Angewandte Psychologie (HAP), Zürich.

Wallner, Teut (1994): Die Handschriftendiagnostik in der Meta-Analyse. Zeitschrift für Menschenkunde 58, 158-163.

Wallner, Teut (2003): Zwischenbilanz – Schriftpsychologische Publikationen der letzten 50 Jahre. ISBN 3-00-012418-7

Wirtz, M. & **Caspar**, F. (2002): Beurteilerübereinstimmung und Beurteilerreliabilität:
Methoden zur Bestimmung und Verbesserung der Zuverlässigkeit von Einschätzungen mittels Kategoriensystem und Ratingskalen. Hogrefe, Göttingen.

Zöfel, P. (2003): Statistik für Psychologen im Klartext. Pearson Studium, München.