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FORENSIC HANDWRITING ANALYSIS ENABLES THE DETECTION OF DEMENTIA CASES

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In many cases, legal psychological expertise includes the evaluation of the cognitive state of a person. In particular, that relates to the cognitive impairment due to dementia. Alzheimer's disease (AD) is the most common form of dementia. There are multiple biomarkers and neurological diagnostic procedures, however, they are often not applicable in the legal context. Handwriting analysis is a potential method for early detection of the onset of the disease. It allows the investigation of current specimens as well as documents from the past, which is especially important for forensic. In the article we present an instrument for screening of possible AD (AD-HS) by handwriting. It includes 40 handwriting and 2 linguistic markers. Their cumulative assessment allows the evaluation of a quantitative AD Indicator (ADI), which reflects the severity level of impairment. The presented validation study includes 48 persons with the AD diagnosis and the control group of 182 handwriting specimens from the database of the HSDetect system for handwriting analysis. The mean value for ADI in the control group equals 0.26 and the 95% level lies at 0.46. All participants have higher ADI value with an average value of 0.46. Besides, the correlation between ADI and the severity of AD was 0.64. That is, AD-HS allows the evaluation of AD severity. The presented approach provides a practical instrument for forensics and criminal expertise. Further refinement of AD-HS and the extension of the experiment data will allow even more reliable screening of cognitive impairment through handwriting.

Keywords: *forensic psychological examination, Alzheimer's disease, indicator of Alzheimer's disease, cognitive impairment in handwriting, dementia.*

Introduction

In many cases, legal psychological expertise includes the evaluation of the cognitive state of a person. When speaking about legal psychology, we mean two fields – forensic and criminal psychology [1]. Forensic psychology deals with law and court trials. That includes criminal, civil, and family contexts. Criminal psychology deals mainly with the psychological aspects of the criminal behavior of individuals and groups.

Objects of expertise, whose cognitive state may be of interest, are not only direct figurants of cases but as well witnesses, family members, etc. Generally, legal psychology

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assessment uses the same methods and instruments as other psychological fields. However, it has strong specifics. First, an explicit investigation of a person is not possible. The person can refuse to cooperate, be not available for a trial, or is already dead. The latter is often the case in testament trials. Secondly, the person under examination cannot be trusted, because he obviously is trying to manipulate the results. Thirdly, we are dealing with past events and it is needed to detect the cognitive state of a person when those events took place, for instance at the time of writing the questioned document. That is, if even the person is available for the trial and the psychological examination can detect his cognitive deterioration, that does not mean that he had the same state several years ago.

The cognitive state might be influenced by stress or disease. In the current article, we are interested in the influence of dementia. The potential dementia state is often important in civil cases and the evaluation of witnesses' credibility. In such cases, psychological handwriting analysis may be very useful. Handwriting is as a learned skill that besides linguistic efforts requires cognitive work to retrieve the learned movements from the brain. For this reason, it may be affected by different diseases, which impact the brain and motoric functions. Handwriting can be affected in the earliest stages of the disease as one of the first signs of deterioration. For this reason, researchers and practitioners are trying to involve handwriting analysis in their investigation since handwriting can identify certain markers of dementia in general and Alzheimer's disease (AD) in particular. Of course, handwriting analysis should not be seen as a diagnostic method, which belongs to medicine. However, in the forensic context, it can be very helpful.

In the current article, we present a screening instrument, which enables the evaluation of handwritten documents and possible markers of AD in handwriting.

Alzheimer's disease and screening of its condition

AD is the most common form of dementia. It accounts for up to 70% of all cases of dementia. Currently, around 50 million people worldwide are affected. Experts expect that the number will triple in the next 30 years. Statistics show that one in 14 people over 65 and one in 2 seniors over 80 suffer from it. AD is a neurodegenerative disorder that affects the brain. It causes impaired memory (at first, usually short-term memory, and in more advanced stages, long-term memory), cognitive impairment, and impaired motor skills. The disease may proceed latent without showing any noticeable signs and for many years. Then cognitive dysfunction, in general, and memory impairment, in particular, start to appear. This period, referred to as cognitive impairment (CI), can last for years. It has been defined as "a transient but progressive phase of cognitive decline that precedes AD" [2]. That is why there is a trend towards earlier diagnosis of AD and CI to delay the onset of dementia.

Traditional diagnosis is based on typical symptoms like memory and orientation loss that individuals and/or their families report to physicians, and on memory tests and additional tests

to exclude other illnesses. In practice, a psychotherapist would use a set of instruments, which includes the observation of the behavior of a person, and information from the family. Several questionnaires were developed and validated. The most popular ones, for instance, Mini-Mental State Examination (MMSE), the Folstein test [3] and the Montreal Cognitive Assessment (MoCA) [4], or the frontal assessment battery (FAB) [5]. There are also structured questionnaires for family members and other people from the surrounding [6]. Many instruments include different tasks, including language, mathematical, and drawing exercises. Being relatively quick and easy to perform, these instruments have poor sensitivity to detecting mild and early dementia. They are practically applicable to persons with highly developed AD.

An earlier screening of AD is being intensively investigated with the help of different biomarkers [7]. Measuring changes in biomarkers can additionally help to better see the progress of the disease.

There are quite a number of known biomarkers in AD. The first type relates to different means of brain imaging: computer tomography, magnetic resonance imaging, and positron emission tomography.

Secondly, cerebrospinal fluid biomarkers (CSF). CSF is a clear fluid that surrounds the brain and spinal cord. It provides protection and insulation and supplies different nutrients and chemicals that help keep brain cells healthy. By measuring changes in the level of these substances we can diagnose neurological problems.

Thirdly, blood tests. Sensitive blood tests include the measurement of proteins that originate in the brain. Levels of these proteins may change because of brain disorders including AD. Nowadays thanks to improved methods of blood analysis the required information can be available. For instance, it is possible to order a blood test to measure levels of beta-amyloid.

Fourthly, genetic testing. Some mutations in genes can lead to dementias including AD. Genetic tests are not often used in clinical settings to predict the risk or diagnose dementia in general and AD in particular. At least they are not routinely used for this. However, when a person has a strong history of AD in the family, a genetic test could be reasonable.

Handwriting analysis for dementia screening in the legal context

Biomarkers are good indicators and are used both by researchers and doctors. Questionnaires are easy and well-accepted. However, they are still mostly used, when a person or his family addresses a doctor, due to the visible signs of AD. In the forensic and legal context, it is not always the case. Often there it is not possible to perform a test since, as mentioned above, the person is not available, dead, or refuses to cooperate. Moreover, many cases deal with old occurrences and documents, written several years ago, and the cognitive state at that time is of interest.

A potential means for early identification of AD is human handwriting. The preclinical and prodromal stages of AD begin decades before the onset of dementia symptoms. At the

cellular level, neuronal activity and neurovascular unit function decline gradually as a consequence of the amyloid cascade. Consequently, enduring skills such as writing and formed handwriting will be more sensitive to early changes in the brain. Saying that we must of course consider that handwriting is also influenced by additional factors. First of all, that is natural aging and concomitant diseases, such as Parkinson's disease and other movement disorders, or multiple sclerosis. Apart from neurological diseases, many somatic diseases such as, for instance, arthritis, osteoarthritis, or respiratory diseases lead to changes in handwriting. Surgery or trauma may also have an impact.

Handwriting is a complex process, perhaps the most complex skill, which a person acquires during lengthy training. Leading American handwriting expert M. Allen [8, p. 15] formulated it as follows: "Handwriting is a highly developed skill which we usually start to acquire in childhood and develop in the following years of adolescence and early adulthood. This is when handwriting becomes mature with an established form, barely changing over the years until factors such as illness and age start to impair it". Handwriting is not limited to fine motor skills. It is not just a motor activity, but also a cognitive and linguistic one: "Handwriting is a complex perceptual-motor skill that differs in many ways from other graphomotor activities, such as drawing or doodling. One of the most obvious differences is, of course, that there is a language system involved, which seems to influence different aspects of handwriting" ([9, p. 353]). Handwriting is a combination of cognitive, kinesthetic, and perceptual-motor components, including such functions as visual and kinesthetic awareness, motor planning, eye-hand coordination, visual-motor integration, and motor dexterity. These characteristics of handwriting allow us to think that handwriting should reflect the disorders associated with AD. Alois Alzheimer himself reported about this in 1907 [10], describing his first patient, Augusta D: “When writing, she reduplicated the same syllable and forgot some others, and, in general, finished very rapidly by stopping” (cited from [11]).

Numerous review studies [11, 12, 13, 14, 15, 16, 17] confirm the strong relationship between AD and handwriting deterioration. So Croislie [11] states: “Writing disorders are an early manifestation of Alzheimer’s disease (AD), often more severe than language difficulties.” Affected people demonstrate diligent but awkward, hesitant writing. Thus, researchers have been intensively using handwriting tasks for the detection of AD markers. In many experimental studies, subjects perform a battery of different writing and drawing tasks. Often they are combined with speech and general cognitive tasks. Typical is the dictating and coping of separate words or short texts. Sometimes studies cover several aspects of writing, but more often they concentrate on one specific aspect. The existing studies can be grouped into linguistic-oriented (linguistic aspects and speech) and motoric-oriented ones.

In the first group, they speak about so-called central dysgraphia [15, 18] and agraphia. The researchers typically ask participants to write a short text. Often that is the description of

a picture [11, 22, 23] or a dictation [19, 20, 21]. Sometimes the task is restricted to just one sentence. Compared to controls, texts written by AD persons are shorter with less relevant information and a high incidence of inappropriate information like semantic substitutions and intrusions. Typically they include some misspellings and errors related to capitalization, punctuation, and paraphasias. Often researchers state added marks and illegible words.

The second group includes research on motoric aspects of writing [24, 25, 26, 27, 28, 29]. That is why often researchers use digitizers/graphical tablets, electronic pens, or other electronic means to automatically register the movements and their characteristics. Often they combine writing, which is restricted to separate words or short sentences, and drawing tasks. Typical research of this type is [29], where researchers asked participants (CI, mild AD, and the control group) to perform five writing tasks on a digitizer: copying a phone number, copying a grocery list (five words), copying the details of a check into the appropriate places, copying the alphabet sequence, and copying a paragraph (107 characters). They measured in-air and on-paper time, velocity, path on paper, and pressure. The result is that persons with CI and AD demonstrated reduced velocity and pressure and extended time and path. With this, these tendencies manifest themselves stronger in AD participants than in CI ones.

The results of many studies are interesting and promising, however, are three major problems in the context of forensics. First, they mainly do not consider the process of handwriting and the result of handwriting in its wholeness. They point out only separate features of handwriting. Among these handwriting signs, dominate those that can be easily measured (on a digitizer) or observed. Linguistic problems can be the result of poor education rather than handwriting degradation.

Secondly, most studies took place in a clinical environment or specially arranged experiments. That does not correctly reflect the conditions of free writing as a normal daily activity. In forensic practice, they deal mainly with documents written some time (maybe years) ago on paper with a normal pen or pencil.

Thirdly, the studies present validated results regarding some handwriting features, but they do not propose a ready instrument to be applied for an expert examination in a forensic environment. One of the few exceptions is [30, 31]. The authors developed a test, which allows a semi-quantitative evaluation. It consists of two scales: verbal & lexical skills and spatial orientation. On each scale, an expert can set a value from 1 to 5. So, the first scale has the following definition:

- No mistakes – 5.
- Some mistakes (for example, missing or wrong letters, words written in a wrong way), however, the text can be easily understood – 4.
- Some mistakes, however, the text can be understood with some effort – 3.
- Some mistakes (as above), the text can be understood only with considerable effort – 2.

- Text not understandable – 1.

The spatial orientation scale:

- Normally oriented rows. In each row, the beginning and end correspond to the page margins – 5.
- Rows slightly distorted or with beginning and end bearing little correspondence to the page margins – 4.
- Rows clearly distorted or with the beginning and end not corresponding to the page margins – 3.
- Words or letters are inserted where they do not belong in the text – 2.
- Chaotic orientation of the rows – 1.

They conclude that "if the writing score is ≤ 5 the subject was probably seriously deteriorated at the time of writing." The positive aspect of this instrument is that it allows a sort of quantitative evaluation. However, it has several problems. First, the included features are too generic and are given without clear rules for their ranking. That relates both to linguistic to handwriting features. How should we interpret "some mistakes"? Are there two or three mistakes? Maybe a certain percentage of words are written with errors? What is the expected text length? What do they mean by "rows slightly distorted"? How many lines? What is the difference between the previous one and non-distorted and straight lines? That is not clear. In their study, the authors compensate for this shortcoming so that the evaluation was done by three of them – a sort of expert consensus. But in practical work that is not reasonable.

Secondly, the test covers only one aspect of handwriting – the spatial organization of lines. That is definitely not enough. Many publications, among which are mentioned above studies, point to many additional handwriting signs that could be AD markers. Our own experience as well shows that many additional handwriting signs could be indicators of handwriting change by AD persons.

Thirdly, the test can provide a really differentiated evaluation. It allows the detection only of rather obvious cases in the developed stage of AD. Some examples given by the authors support this statement.

AD-HS screening instrument

For several years we have been working on the development of an instrument that may be practically used to evaluate the possible AD status mainly in the forensic context. The result is the AD-HS instrument. It covers all aspects of handwriting as a complex cognitive and motoric activity. It is intended for initial screening and identification of the progress of the AD status. Our motivation is that writing by hand is a normal daily activity and thus can be a good indicator of cognitive and motor changes. An important point is that it can be used outside the special experiments, which are not natural for participants, and where the results are influenced by this special arrangement.

The development of AD-HS is based on several principles. First, experts should preferably take naturally written documents for handwriting analysis. That should be a free text, rather than a special writing task so that a person think over the content and not just mechanically write dictated words. The text should be large enough to include as many handwriting signs as possible. It is better to use normal paper writing. Electronic equipment allows precise measurement of certain handwriting features, however, it lacks the desired naturalness of writing.

Secondly, many researchers point to heterogeneous results of their studies [14, 15, 32]. That means, in some subjects, the proposed markers are visible, in others they are absent. That is, there are no certain handwriting features that definitely identify CI or AD. There is a set of possible markers and if more of them are detected in the analyzed text, the higher the probability of CI/AD. Thus the cumulative presence of markers should form a quantitative indicator.

Thirdly, linguistic markers are also important in written texts. In some works, they were overestimated, but we should not underestimate and ignore them. Thus linguistic markers should be included.

Fourth, also it is very popular to analyze signatures, multiple studies, for instance [32, 33] demonstrated that signature typically keeps stable with the onset and progression of AD and with natural age-related changes. Thus characteristics of the signature cannot be markers. Other dementia forms like Parkinson's disease do influence signature, but AD does not.
AD-HS was developed based on three major sources of information. First, the existing studies. Secondly, our discussions with neurologists. Thirdly, the results of our statistical research, which is based on a standard handwriting protocol of the HSDetect framework [34, 35, 36] for handwriting analysis. The protocol covers all aspects of handwriting and includes about 200 handwriting signs and over 700 handwriting characteristics. Under a handwriting sign, we understand a certain feature of handwriting, for instance, letter size. Under characteristics we understand particular manifestations of the sign, for instance, for the size there are five following ones: average, small, very small, large, and very large. Every handwriting specimen in our experiments is evaluated according to the protocol, and correlation analysis allowed the detection of those handwriting characteristics, which are typical for CI and AD.

Currently, AD-HS includes 40 handwriting characteristics and two linguistic ones [37]. I'm writing "currently" because the permanent addition of new participants with their handwriting specimens enables updating of statistical data. Among handwriting characteristics in AD-HS, there are some very generic and supported in many studies. For instance, general instability of handwriting (instability of size, width, slant, horizontal and vertical intervals), light pressure, slow speed of writing, uneven line form and line direction, or big size. Other

characteristics are not very known in the context. For instance, high placement of diacritic signs, vertical and horizontal offset of punctuation marks, etc.

A psychological construct is modeled in HSDetect as a linear regression:

$$Y = \sum a_i \cdot x_i \quad (1)$$

Here variable x_i denotes the level of presence of i-th handwriting characteristic in the analyzed specimen. Generally in HSDetect x_i changes from 0 (the handwriting characteristic does not present) to 1 (the handwriting characteristic presents absolutely). Regression coefficients a_i denote the weight of i-th handwriting characteristics. They are defined so, that Y changes from 0 to 1.

In our case, AD-Indicator (ADI) is also a psychological construct with some particularity. First, we included two linguistic features, which are not typical for handwriting analysis. Secondly, since there are rather many independent variables, we define all weights $a_i = 1$ and all variables x_i as binomial, i.e. either 0 or 1. Later, when we have more statistical data these assumptions may be reconsidered. Our streamlining results in Y being evaluated as the number of present handwriting characteristics divided by 42 (the total number of variables).

The evaluation of handwriting is a manual procedure. Currently, no software exists, which can evaluate required handwriting signs automatically, parsing a scanned handwritten document. Existing analytical programs like CedarFox[3], MovAlyzeR[4], Masquerade[5], or others cannot cover all required handwriting signs, and even for those signs, which are included in a program, the proper quality and rather simple handwriting specimens, which is not the case with AD research. In recent years, there were some interesting and promising results with artificial intelligence methods, mainly with artificial neural networks. However, they are still not mature enough for practical usage. So the research should be based on a manual evaluation of handwriting. For manual evaluation, it is very important to have an exact formal definition of signs and characteristics. That ensures the required level of objectivity and reliability. Such definitions are part of HSDetect [39].

[3] https://cedar.buffalo.edu/
[4] https://neuroscript.net
[5] https://www.nitesrl.com/products/masquerade/

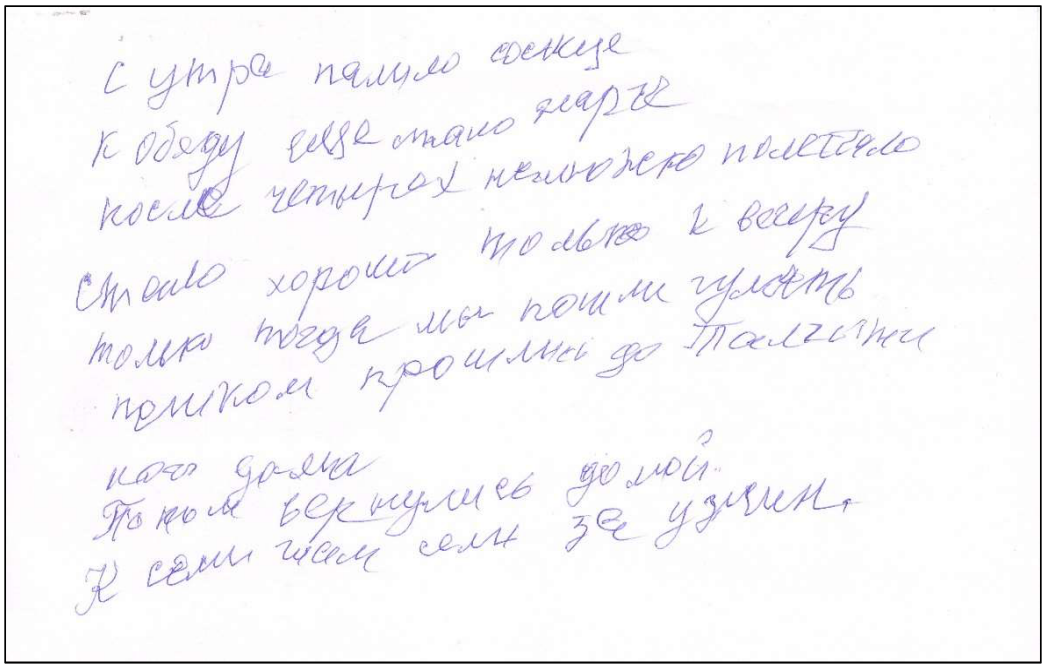

Figure 1. AD handwriting, example 1 (Cyrillic)

Some handwritings demonstrate the more or less obvious influence of the disease on handwriting (figures 1 and 2). By others, only a profound analysis of the specimen reveals the markers.

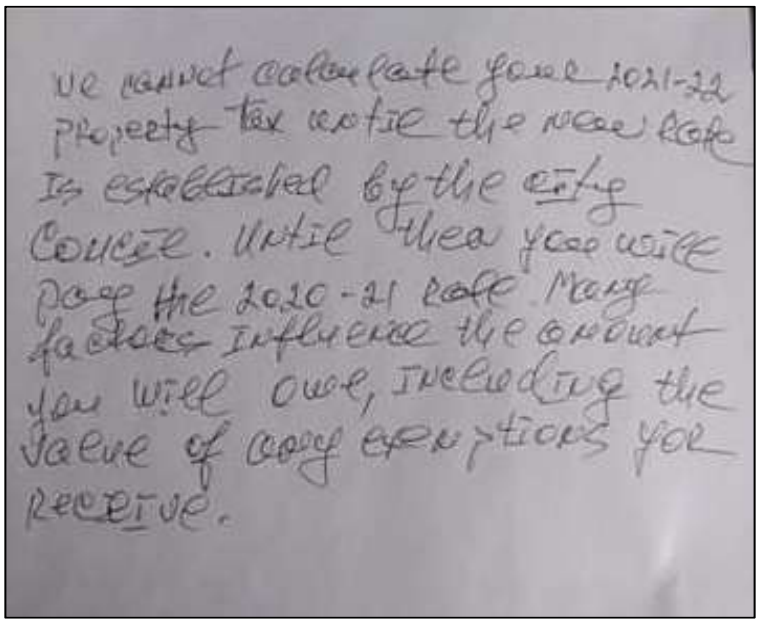

Figure 2. AD handwriting, example 2 (English)

Validation study

The preliminary results of the validation study were published in [37, 38]. In the current article, we see the extension of the validation experiment. It includes 48 participants aged from 59 to 83. Among them are 26 women and 22 men from Kazakhstan, Germany, Poland,

Switzerland, Russia, the UK, and the USA. All of them were diagnosed with AD by neurologists and they are at different stages of the disease. For 19 of them, a quantitative evaluation of the severity on a four-value scale is available. All subjects provided handwriting specimens of free text in Russian, English, Polish and German languages. The major part of the texts was written not especially for the experiment. Twenty participants additionally provided texts written 10-20 years ago, i.e. when AD had not been diagnosed yet.

As a control group, we took 182 handwriting specimens from the HSDetect database. These specimens have been evaluated in recent years by other research, not related to the AD study. Based on their evaluation we calculated individual values of ADI. The mean value equals 0.26 (let us call it a normative value ADI-N) and the standard deviation equals 0.09. 75% of subjects in the control group have ADI < 0.32 (ADI-0.75 = 0.32), and 95% have ADI < 0.46 (ADI-0.95 = 0.46).

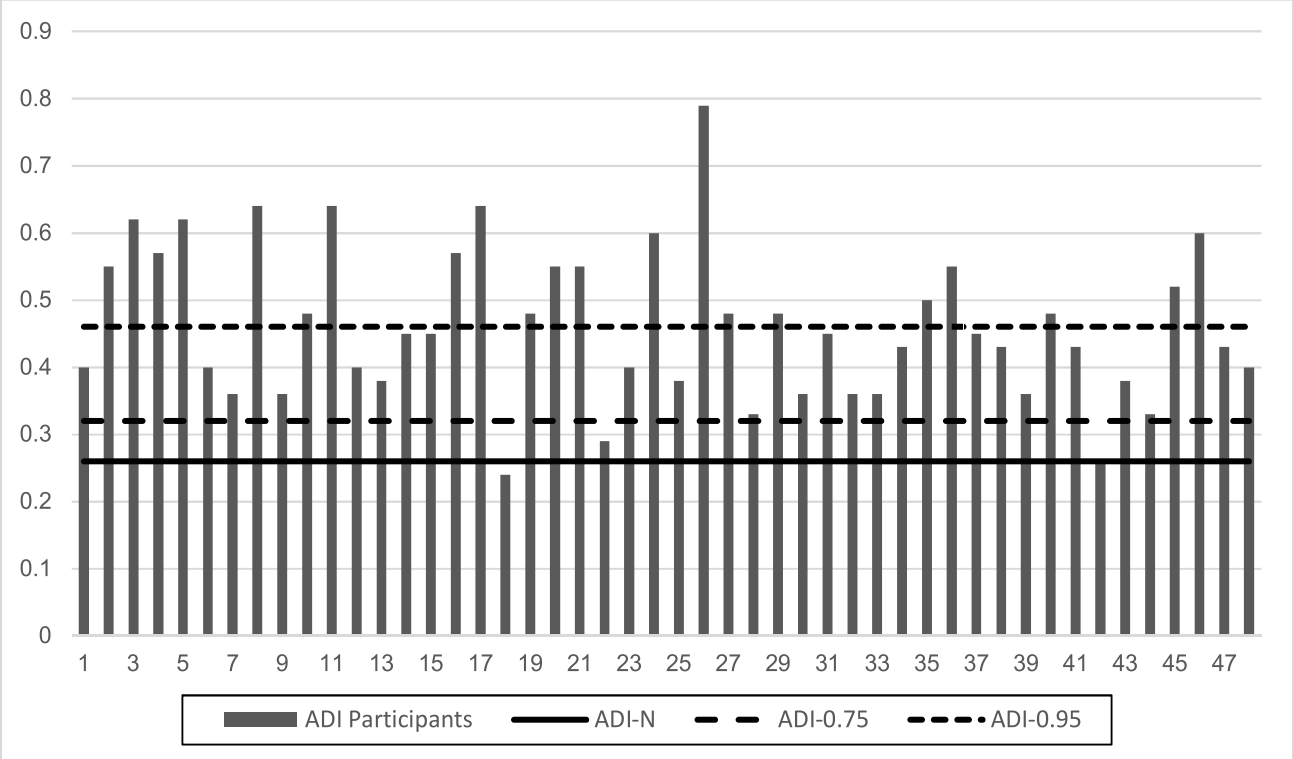

Figure 3. ADI Evaluation

The result of the ADI calculation is shown in figure 3. We can see that most of the ADI values are much higher than in the control group. The mean value equals 0.46. That validates the procedure and speaks for the high effectiveness of AD-HS.

As it was stated above, the combination of AD markers is individual for every person. For some of them the frequency of occurrence is high, for instance, for large size it equals 0.58 for unstable size it equals 0.73. Others demonstrate lower frequency, like large spaces between words – 0.15 or mixed letters from – 0.13.

In the neurological context, it is especially important that AD-HS can provide an early screening. The following example (figure 4) demonstrates a handwriting sample of women at age of 67. It was taken in 2014. At that time no visible signs

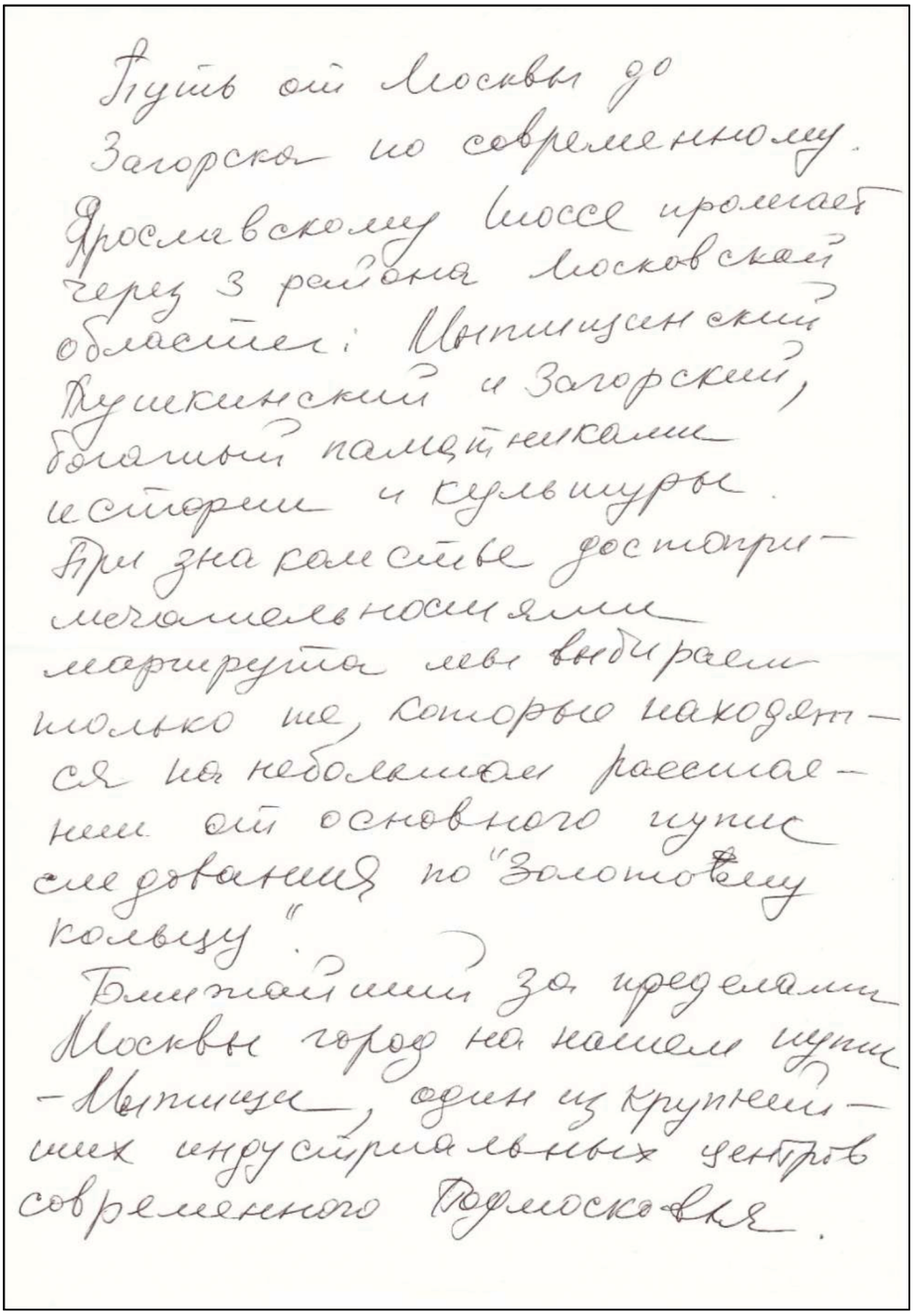
Путь от Москвы до
Загорска по современному.
Ярославскому шоссе проходит
через 3 района Московской
областей: Мытищинский
Пушкинский и Загорский,
богатый памятниками
истории и культуры.
При знакомстве достопри-
мечательностями
маршрута мы выбрали
только те, которые находят-
ся на небольшом расстоя-
нии от основного пути
следования по "Золотому
кольцу".
Ближайший за пределами
Москвы город на нашем пути
- Мытищи, один из крупней-
ших индустриальных центров
современного Подмосковья.

Figure 4. AD case, women 65

of AD could be registered. Today she is in deep dementia and cannot recognize her relatives. Although visibly nothing catches the eye in her handwriting, the thorough evaluation gives ADI = 0.59, which is very high. That means the development of AD could be predicted many years ago.

AD severity identification

For the 19 participants, the AD level was ranked by a neurologist. The ADI values were transferred into ranks, and the Spearman rank correlation was calculated [37].

The correlation coefficient equals 0.64, which is rather high. That denotes, that the ADI reflects well the severity level stated by neurologists.

Handwriting deterioration

Some participants (19) were able to provide their old handwriting specimen, written 10-20 years ago. It was detected that with time the number of AD markers increased for all participants. The number of additional AD markers in new specimens changes from 7 to 20 with an average value of 12. The most often changes are the increase in size, the deterioration of lines, the weakening of pressure, reduced energy, increasing of disconnectivity of the first letter, the reduction of the upper zone, and increased general inconsistency (general and in separate characteristics).

Discussion

Following our experience and the described validation study, we can conclude that the AD-HS instrument allows good identification of AD. It is rather reliable and supports a distinguished screening of AD progress. However, it should be pointed out that handwriting analysis is by no means a diagnostic tool. This is actually not required in the legal context. The instrument only provides a certain indication. Especially, it can be useful when a medical opinion about the patient's illness cannot be obtained. The last is often the case in forensics. Secondly, of course, such a small sample does not yet allow us to draw far-reaching conclusions. But the results are clear and unambiguous, which makes them promising.

AD-HS includes many “conventional” handwriting characteristics. Every one of them for itself does not denote any indication. That is why, as we already emphasized above, only an analysis of all characteristics should be considered reliable.

Some questions are still open and require further research. First, AD is more common among older people. Some handwriting characteristics in AD-HS are typical for older persons. Our sample consists of AD patients. However, that doesn’t mean that handwriting of persons without AD cannot manifest the same characteristics. So, better separation of markers of AD should be done, although these two attributes – AD and age are strongly correlated.

Secondly, the same problem as with age we have with other diseases. Often they manifest themselves similarly in handwriting. In some cases, the difference is clear, like with Parkinson’s disease, which is another form of dementia [40]. For Parkinson’s handwriting, very typical micrography – handwriting becomes smaller. That definitely contrasts with AD. With other diseases, this should be further researched.

Third, in the study, we used the simplest binomial variant of the model (1). Further

research with more complicated models, which include a quantitative definition of handwriting characteristics and their weights, could gain some additional information with larger samples.

Fourth, it would be very practical to use a software program to evaluate handwriting specimens. As we have mentioned above, that is still not possible. However, new approaches based on deep learning and other artificial intelligence methods, which were not very practical for handwriting analysis, are intensively improving themselves and more practical results can be achieved. In particular, in forensic handwriting analysis [41]. We intend to work for the further improvement of these algorithms and the collection of even more handwriting samples for the teaching sets. That will enable the development of a fully automated AD-HS instrument.

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ԴԱՏԱՁԵՌԱԳՐԱԲԱՆԱԿԱՆ ՓՈՐՁԱՔՆՆՈՒԹՅՈՒՆԸ ԴԵՄԵՆՑԻԱՅԻ ԴԵՊՔԵՐԸ ՀԱՅՏՆԱԲԵՐԵԼՈՒ ԴԵՊՔՈՒՄ

Չեռնով Յու.Գ.

Սույն հոդվածում դիտարկվում են անձի դեմքի ճանաչողական վիճակի գնահատականը ներառող դատահոգեբանական փորձաքննության դեպքեր: Մասնավորապես, զգալի ուշադրություն է դարձվում դեմենցիայի հետևանքով ճանաչողական խանգարումներին: Նշվում է, որ Ալցհեյմերի հիվանդությունը համարվում է դեմենցիայի առավել տարածված տեսակը: Ընդգծվում է, որ կան բազմաթիվ կենսամարկերներ և նյարդաբանական ախտորոշիչ ընթացակարգեր, սակայն դրանք իրավական համատեքստում հաճախ ընդունելի չեն: Աշխատանքում հիմնական ուշադրությունը սևեռված է ձեռագրի վերլուծության վրա, ինչը, հեղինակների կարծիքով, հիվանդության վաղ հայտնաբերման պոտենցիալ մեթոդ է: Սա թույլ է տալիս ուսումնասիրել ընթացիկ նմուշները, ինչպես նաև ավելի վաղ փաստաթղթեր, ինչը հատկապես կարևոր է քրեագիտության համար:

Հոդվածում ներկայացված է Ալցհեյմերի հնարավոր հիվանդության (AD-HS) ձեռագրի զննման գործիք: Ամփոփված է 40 ձեռագիր և 2 լեզվական մարկեր ներառող գործնական փորձ, որոնց կումուլյատիվ արժեքը թույլ է տալիս գնահատել Ալցհեյմերի հիվանդության քանակական ցուցանիշը (Ալցհեյմերի հիվանդության ցուցիչ), որն էլ արտացոլելում է խանգարման ծանրության մակարդակը: Ներկայացված վավերացման հետազոտությունը ներառում է Ալցհեյմերի հիվանդությամբ ախտորոշված 48 մարդու և HSDetect ձեռագրի վերլուծության փվյալների բազայից 182 ձեռագրի նմուշների հսկիչ խումբ: Կատարված հետազոտությունների ընթացքում նշվում է, որ հսկիչ խմբում Ալցհեյմերի հիվանդության ցուցիչի միջին արժեքը 0,26 է, իսկ 95% մակարդակի դեպքում՝ այն կազմում է 0,46: Բոլոր մասնակիցներն ունեն Ալցհեյմերի ցուցիչի ավելի բարձր արժեք՝ 0,46 միջին արժեքով: Բացի այդ, մատնանշվում է Ալցհեյմերի հիվանդության ցուցիչի և Ալցհեյմերի հիվանդության ծանրության կոռելյացիան, որը կազմել է 0,64:

Այսպիսով, AD-HS-ը հնարավորություն է տալիս գնահատել Ալցհեյմերի հիվանդության լրջությունը: Հեղինակը գալիս է այն եզրահանգման, որ հոդվածում նկարագրված մոտեցումը դատափորձագիտական հետազոտության գործնական գործիք է: Հիմնավորվում է գաղափարն այն մասին, որ AD-HS-ի հետագա ճշգրտումը և փորձարարական փվյալների ընդլայնումը թույլ կտան բարձրացնել ձեռագրի ճանաչողական խանգարումների հայտնաբերման հուսալիությունը:

Բանալի բառեր. *դատահոգեբանական փորձաքննություն, Ալցհեյմերի հիվանդություն, Ալցհեյմերի հիվանդության ցուցիչ, ձեռագրի ճանաչողական խանգարում, դեմենցիա:*

СУДЕБНО-ПОЧЕРКОВЕДЧЕСКАЯ ЭКСПЕРТИЗА ПРИ ВЫЯВЛЕНИИ СЛУЧАЕВ ДЕМЕНЦИИ

Чернов Ю.Г.

В данной статье рассматриваются случаи судебно-психологических экспертиз, включающих в себя оценку когнитивного состояния лица. В частности, значительное внимание уделяется когнитивным нарушениям вследствие деменции. Отмечается, что болезнь Альцгеймера является наиболее распространенной формой деменции. Подчеркивается, что существуют множество биомаркеров и неврологических диагностических процедур, однако они часто не применимы в правовом контексте. Основное внимание в работе акцентируется на анализе почерка, который на взгляд авторов является потенциальным методом раннего выявления начала заболевания. Это позволяет исследовать текущие образцы, а также документы из прошлого, что особенно важно для криминалистики. В статье представлен инструмент для скрининга возможной болезни Альцгеймера (AD-HS) по почерку. Обобщается практический опыт, который включает в себя 40 рукописных и 2 лингвистических маркера. Их кумулятивная оценка позволяет оценить количественный показатель болезни Альцгеймера (индикатор болезни Альцгеймера), отражающий уровень тяжести нарушения. В представленное валидационное исследование включены 48 человек с диагнозом болезни Альцгеймера и контрольная группа из 182 образцов почерка из базы данных системы почерковедческого анализа HSDetect. В ходе выполненных исследований отмечается, что среднее значение индикатора болезни Альцгеймера в контрольной группе равно 0,26, а уровень 95% составляет 0,46. При этом все участники имеют более высокое значение индикатор болезни Альцгеймера со средним значением 0,46. Кроме того, указывается, что корреляция между индикатором болезни Альцгеймера и тяжестью болезни Альцгеймера составила 0,64. Таким образом, AD-HS

позволяет оценить серьезность болезни Альцгеймера. Автор приходит к выводу, что описанный в статье подход представляет собой практический инструмент для судебно-экспертных исследований. Обосновывается мысль о том, что дальнейшее уточнение AD-HS и расширение данных эксперимента позволит повысить надежность выявления когнитивных нарушений по почерку.

Ключевые слова: *судебно-психологическая экспертиза, болезнь Альцгеймера, индикатор болезни Альцгеймера, когнитивные нарушения по почерку, деменция.*

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