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ANALYSIS OF THE FORMATION OF THE FINAL PART OF THE SIGNATURE (SWIRL) – FAMILY FACTOR

Summary

The article is a continuation of a research project on factors affecting the process of formation of a young person's signature, which we started in 2022. In the pages of the journal *Current Problems of Forensic Science* that year, we published an article in which we wrote that the importance of the signature in the social life of a person in the 21st century is still very important. In the process of socialization, a young person must accept responsibility for certain decisions, which are often accompanied by the signing of documents. One of the less recognized issues in handwriting research is the process of signature formation and the factors that influence this process. In the aforementioned article, we focused our attention on issues of imitation in the signatures of young people and on the similarity of some general features (synthetic, structural, and motor) of their signatures with those of other family members. In this article, we would like to present the results of our research, concerning the formation of the final segment of the signature - the swirl², which from the point of view of an expert scribe has a significant

¹ All co-authors of this article are active members of the Lithuanian Forensic Society.

² One of the problems we face in our efforts to bring together and harmonize the paradigms of forensic science in Europe are certain traditions and well-established stereotypes, various interpretations of the use of concepts, definitions and terms in different countries. In Lithuania, the main expert institution (the Lithuanian Center for Forensic Expertise) has its own internal recommendations on the use of certain concepts and terms. According to these recommendations and the information contained in forensic science textbooks, the structure of a signature

identification value, since it is usually characterized by the highest degree of automaticity. As a result of our examination of the signatures of 407 people, only in 24 we did not find the presence of this element in the signatures (initials). The study was conducted to analyze the impact of the graphism of family members' signatures on this final part of a young person's signature as well.

In this study, we wanted to determine whether the degree of influence of older family members on the formation of the last part of a young person's signature (swirl) has an analogous level of imitation, or whether we encounter more variation, which is due to other factors, including those linked to certain personality traits. In this regard, the study is a pilot.

Keywords: forensic science, scribal expertise, graphology, graphism, signature, initials, final part of signature, swirl, research experiment

Introduction

As we strive to create a common European forensic space, we must make corresponding efforts to bring together the paradigms of forensic science and forensic expertology of European countries, and this must be served by the language of forensic science. Unfortunately, many areas still use different terms and definitions by which we define the same objects, phenomena, or processes. Our goal - which the research and the publications based on it are designed to achieve - is not only to analyze a specific phenomenon (in this case, the influence of family members on the process of formation of a young person's signature, which has both scientific and applied value) but also to present the results of this research to our friends from other countries and to draw attention to the possibility of cooperation

(according to our interpretation, as it differs from the definition of a signature as a full-letter writing of the first and last name accepted in Poland) most often consists of three basic elements: a monogram, a middle letter or non-letter part, and the final part, called a swirl (lit. monograma, neraidinė vidurinė parašo dalis ir parašo užraitas su galimais papildomais elementais) - See E. Kurapka, H. Malewski, E. Palskys, S. Kuklianskis, *Kriminalistikos technikos pagrindai (vadovėlis)*, Eugrimas, Lietuvos teisės akademija, Vilnius 1998, p. 218. The term, according to dictionaries, "užraitas" is very often translated into English as "swirl," with the indication that it may be the final part of the signature (initials). In the Polish doctrine of scribal research, another term is preferred - "adjacency", which was also pointed out by the reviewer of this article. "ADJUSTMENT - a graphic element that is an extension on the ground of the previous movement of the hand in the air before the start of the basic activity of writing (initial adjuration) or preparation for the movement of the hand in the air when detaching it from the ground (final adjuration). Adjacency takes the form of faint lines. See also hairline" (A. Koziczak, M. Owoc (eds.), *Słownik terminów pismoznawczych*, Instytut Ekspertyz Sądowych im. Prof. dra Jana Sehna w Krakowie, Kraków 2014, s. 5). The reviewer's comments and suggestion to use the term "swirl" instead of the term (concept) "adjuration" did not convince us, as they refer to different elements of the signature (initials).

in this field³. Even a fragmentary (piecemeal) presentation of the results of the research makes it possible to learn more about the doctrinal assumptions of forensic science and forensic expertology in neighboring countries (Poland, Ukraine, Latvia, Estonia, or Germany), and thus strive to bring the paradigms of these sciences closer together in the process of creating a common European forensic space.

This article is based on the materials of an informal research project on the factors influencing the process of formation of a young person's signature, especially the family factor, which we started in 2022 and whose preliminary results were published in the pages of the journal *Problems of Contemporary Forensic Science* in that year⁴.

At the outset, we must point out that the concept and definition of signature in the law and forensic doctrines of various countries are defined ambiguously. The laws of some countries require the signature to be a full letter transcription of the person's name, and a non-letter or abbreviated version of the name is considered initials. In other countries, the issue of the statutory definition of the parameters of the signature (initials) is being raised, and there are proposals to consider the signature on an ID card as the official, model signature (initials) of a person.

What is a signature in the legal-criminal area of Lithuania, in Poland is most often referred to as a *parafa*⁵. *Parafa* (Fr. *paraphe* from Gr. *paragrapbos*) is 1) an abbreviated signature on a document, business letter, etc.; 2) initials instead of a signature⁶.

According to Mieczysław Goc, "Signatures can appear in various forms, as:

- legible signatures (full-sounding, abbreviated, e.g., including only the surname part),
- partially legible (simplified, containing illegible forms alongside characters with recognizable legibility),

³ At the 21st Wrocław Symposium on Writing Research, Dr. Olivia Rybak-Karkosz presented a paper titled *Family similarities of graphisms in painting signatures in the case of consanguinity in the direct line (on the example of Jacek and Raphael Malczewski)*.

⁴ See H. Malewski, R. Tamošiūnaitė, V.E. Kurapka, S. Matulienė, *Proces formowania się podpisu: czynnik rodzinny*, „*Problemy Współczesnej Kryminalistyki*” 2022, vol. XVI, pp. 215-233 (Polish version) (*Signature formative mechanism: family factor*, pp. 235-254).

⁵ A. Koziczak, *Definicja parafy – potrzeba konwencji*, in Z. Kegel (ed.), *Materiały VII Wrocławskiego Sympozjum Badań Pisma*, Katedra Kryminalistyki Uniwersytetu Wrocławskiego, Wrocław 1997; A. Kotarba-Pawłowicz, M. Pająk, *Badanie paraf pod kątem ich podobieństw*, in Z. Kegel, R. Cieśla (ed.), *naczenie aktualnych metod badań dokumentów w dowodzeniu sądowym*, Uniwersytet Wrocławski, Wrocław 2012, pp. 185-193.

⁶ See *Parafas*, <https://www.lietuviuzodinas.lt/terminai> (accessed March 04, 2024).

- illegible (developed or short initials),
- monograms (a specific type of signature in the form of legible initials of the first letters of the first name and surname or only one of these parts)⁷.

Another Polish researcher, Antoni Felus, points out that there are signatures in letter transcription consistent with the person's name transcription, as well as simplified signatures. He divides simplified signatures into monograms, abbreviated signatures, and initials⁸. Problems related to the study of signatures are widely analyzed in the works of Anna Koziczak⁹ and many other Polish researchers¹⁰. The diversity in the opinions of scientists from even one country shows how complex the process of convergence of views is and how difficult a road we have to travel to talk about a common European forensic space.

In Lithuanian doctrine, a signature is defined as a handwritten graphic sign reflecting the name of a specific person, with which a fact of legal significance is usually confirmed. The person whose name is indicated in the document must always sign. Most often, a person signs in a specific, characteristic way, **which generally differs from the form in which his name is written** (emphasis - H.M.) in a given document. The signature may consist of all or only a few letters of the surname, non-letter elements, a finalizing element (swirl) diacritical marks, and additional elements¹¹. In the given article we do not cover the topic of digital signatures.

Purpose of the study: to determine whether the final part of a young person's signature (swirl) forms under the influence of the signature patterns of family members. First-year students of the Michael Romer University Public Security Academy and their family members were selected for the study. The survey was conducted between 2022 and 2023 in three stages.

⁷ E. Gruza, M. Goc, J. Moszczyński, *Kryminalistyka, czyli o współczesnych metodach dowodzenia przestępstw*, Wolters Kluwer, Warsaw 2020, p. 509.

⁸ See A. Felus, *Podpisy. Studium z pismoznawstwa kryminalistycznego*, Uniwersytet Śląski, Katowice, 1987, p. 16.

⁹ A. Koziczak, *Metody pomiarowe w badaniach pismoznawczych*, Wydawnictwo Instytutu Ekspertyz Sądowych, Cracow 1997; eadem, *Autofalszerstwo*, Difin, Warsaw 2020.

¹⁰ *Wybrane aspekty kryminalistycznych badań paraf, podpisów i znaków diakrytycznych*, zeszyt nr 12, Wydawnictwo Centralnego Laboratorium Kryminalistycznego KGP, Warsaw 1996; M. Goc, *Badania podpisów w kryminalistycznej ekspertyzie pismoznawczej – wybrane zagadnienia metodyczne*, „Problemy Kryminalistyki” 2009, no. 263.

¹¹ See E. Palskys, *Kriminalistinis dokumentų tyrimas*, Aukštojo ir specialiojo vidurinio mokslo ministerija, Vilnius 1978, pp. 77-79; E. Kurapka, H. Malevski, E. Palskys, S. Kuklianskis, op. cit. pp. 216-217; V.E. Kurapka, S. Matulienė (eds.), *Kriminalistika. Teorija ir technika*, Mykolo Romerio universitetas, Vilnius 2012, pp. 554-556.

Research hypothesis: analysis of conducted studies of the influence of graphism of signatures of older family members on the formation of a young person's signature showed that such a relationship exists, as we wrote about in the aforementioned 2022 article. In our opinion, the swirl (the final part of the signature) has some specific features by which it differs from the letter parts of the signature. To what extent does the form of the signature (image-construction) of older family members influence the formation of the last part of the signature (swirl) of a young person, and whether they are similar or distinctly different, may be due to at least several factors, namely, the degree of handwriting and signature, and also be linked to certain personality traits, such as creativity, accuracy or conformity.

Research methods: analysis of documents and scientific sources, comparative method, experimental method, generalization method.

Some remarks on the process of formation of the signature (initials) from the point of view of forensics and graphology (psychology of writing), taking into account the peculiarities of its final part (swirl)

In our research on the formation of a young person's signature and the factors influencing this process, we have noticed that certain areas of writing and signature research have received a huge amount of research and publication, while others remain on the margins of scholarly interest. In recent years, electronic signatures have attracted great interest, resulting in a large number of publications in this field. Another area that is attracting the attention of researchers is the use of artificial intelligence, including in the field of forgery (creation) of signatures¹². In our opinion, there are disproportionately few works devoted to studying the formation of a young person's traditional signature and the factors that influence this process. We therefore focus attention on the family factor, which, through conscious or unconscious imitation, influences this process. In this study, we have decided to focus on the final part of the signature - the swirl¹³, which has not received more extensive studies. *The Encyclopedia of Forensic Expertise* provides the following definition of this element: "The swirl is the final part of the signature. The swirl is formed as a result of the continuation of movement

¹² Examples include the papers delivered at the 21st Wrocław Symposium on Scripture Research: Dr. Maciej Marcinkowski-Prażmowski *Artificial intelligence for signature forgery*, or Prof. Piotr Bilski *A system for identifying the originality of a handwritten signature using artificial intelligence*.

¹³ In the Polish literature on the subject, it is more common to encounter the concept of the final part or element of the signature. Signature swirl (Lithuanian - parašo užraitas; Russian - росчерк подписи; ukr. - розчерк підпису).

during the formation of the last letter or non-forming grammar; the deformation of the last letter; the merging of the last letter with the superlinear grammar during the increase of its size.”¹⁴ In our opinion, the lettered parts of the signature have a great deal in common, and one can even speak of analogous identification features of their graphism, comparing them with traditional handwriting. Our research hypothesis was that the swirl (the final part of the signature) has certain specific features by which it differs from the letter parts of the signature. One of them is usually the highest degree of automaticity compared to the letter parts of the signature. In turn, the analysis of practice gives grounds to claim that in signature forgeries, it is not uncommon to have authentic features of the final segment, characteristic of the forger’s signature. On the other hand, in the auto forgery of signatures, its final part is not infrequently significantly altered.

When writing about the formation of a young person’s signature, we must emphasize that this is a learning-based process. One of the key elements of learning is imitation and repetition of certain activities. Imitation is the act of copying, modeling, or repeating the actions or behavior of another person. It is a very advanced way of learning because it allows us to learn something that the other person knows or knows. Often people learn in a way they intuitively think is right. The purpose of this study is to determine how the final part of a person’s signature is formed, what factors are important in the creation of the signature, and in the selection of certain features of the swirl (graphism, its general and specific features).

The brain is the largest part of the human central nervous system, where highly complex neurophysiological processes take place; one of which is linked to the ability programmed into our genes to imitate and learn. Through systematic and gradual imitation and repetition of a certain activity, one gains experience and skill in performing it.

Signature creation is often the result of mimicking and repeating the signatures of parents¹⁵, resulting in an individual identification object. We must emphasize that over time a young person’s signature gradually deviates from the pattern of parents or other family members, which is related not only to a person’s creativity but also to the improvement of writing

¹⁴ “Росчерк, заключительная часть подписи. Росчерк формируется за счет: продолжения движения при выполнении последней буквы либо штриха, не образующего букву; деформации последней буквы; соединения последней буквы с ее надстрочным штрихом при увеличении размера этого штриха”. See Т.В. Аверьянова, Е.Р. Россинская (ed.), *Энциклопедия судебной экспертизы*, Юристъ, Москва 1999, p. 375.

¹⁵ H. Malewski, R. Tamošiūnaitė, V.E. Kurapka, S. Matulienė, op. cit.

skills, etc. Thus, a signature is not only a graphic image but also a sign that identifies a person.

Signature formation begins as early as school at around 13-16 years of age. Sometimes this manifests itself as a desire to show independence, individuality, and other certain character traits, but sometimes it is only because a signature will be required for the receipt of personal documents.

The first letters of the first and last name are not infrequently the basis for a signature. These are identifying elements that describe a person. Some individuals leave such a simplified signature for life. Others choose a form that is more informative and distinctive, or even “sophisticated,” as they extend it with spelled or unspelled elements, swirls, and even additional diacritical marks (Fig. 1).

Fig. 1. A simplified variant of the signature, formed from the first letters of the first name and last name, and a complex, made-up signature consisting of a monogram, a middle segment, and a swirl with a complementary dash



Source: Archives of the Lithuanian Center for Forensic Expertise.

Undoubtedly, the signature not only has a utilitarian meaning but also expresses (presents) certain individual characteristics of a person’s personality and character. It is a kind of business card that we want to show “to the world”, just like our clothing, style of behavior, etc. Signatures with very sophisticated construction indicate that someone wants to look not only positive, not only to impress others but also to show their “uniqueness”¹⁶. The complexity, refinement, or even sophistication of the signature style is influenced by other factors as well, including one’s profession, position, sense of responsibility for one’s own decisions, etc. Such examples include signatures of notaries, experts, and representatives of certain other professions.

¹⁶ Д.М. Зуев-Инсаров, *Почерк и личность (Способ определения характера по почерку, графологический метод изучения личности)*, Москва 1930, p. 13, <https://studfile.net/preview/10070591/> (accessed 08.03.2024); K. Gravelle, *Kaip pažinti save*, Vilnius 2003.

Fig. 2. An example of a sophisticated signature with a complex swirl structure



Source: Archives of the Lithuanian Center for Forensic Expertise.

We must take into account that under the influence of various factors, sometimes consciously, sometimes not, not only graphism but also the structure of the signature changes.

Analyzing the process of the formation of the signature and its final element - the swirl, it is worth noting the connections of graphism with personal characteristics and, in the first place, with the temperament of the person. Problems related to signatures and more generally to handwriting are of interest not only to forensic science but also to many other disciplines, including graphology, psychology, neurology, etc. It should be noted that the scientific basis of forensic science was established in the second half of the 19th century, and the study of writing had been carried out for at least several centuries before that. Much earlier, graphology emerged as a discipline that primarily studies the connections and interdependence between a person's personality and handwriting¹⁷. It is worth noting that not only in the late 19th and early 20th centuries the forensic examination of handwriting was often referred to as graphology¹⁸, but we also encounter the term today¹⁹. In today's search engines, the phrase "handwriting examination" is often associated with the keyword "graphology." Sometimes the examination of handwriting is referred to as graphology even in legal documents. It is also worth noting that in the West not everyone recognizes graphology as a science. Gérard Douatte, for example, considers it only a technique, since

¹⁷ Д. М. Зуев-Инсаров, *op. cit.*

¹⁸ H. Kwiecinski, *Grafologia sądowa (zasady ekspertyzy dokumentów i analizy pisma)*, Biblioteka Polska, Warsaw 1933.

¹⁹ R. Känzig, *W jakim zakresie może wnieść grafologia swój wkład do prac kryminalistycznych?*, in Z. Kegel (ed.), *Kryminalistyczna ekspertyza pismoznawcza a grafologia: materiały X Wrocławskiego Sympozjum Badań Pisma*, Uniwersytet Wrocławski, Wydział Prawa, Administracji i Ekonomii, Katedra Kryminalistyki, Wrocław 2003, pp. 121-128.

it does not use measurements or other quantitative characteristics²⁰. In the Eastern European school of forensic science, graphology was not seen as a scientific discipline for a long time and was even described as a pseudoscience, ranking with astrology and palmistry, although in Western Europe there were already elaborate graphological theories and it was taught at renowned universities. Gradually, these radical views rejecting graphology *in corpore* have been revised, and increasingly knowledge from this area is being used in scribal research, including to determine a person's emotional state or state of alcoholic (drug) intoxication, to determine gender, etc.²¹

Viewing the study of signatures through the prism of graphology is important not only for historical reasons but also because the first graphological descriptions of handwriting laid the foundation for the formation of a system of general and specific handwriting characteristics, which has benefited modern scribal expertise. The Dictionary of the Lithuanian Language defines graphology as “the study of handwriting and signatures along with their relationship to a person's character”²². A more extensive article on graphology is included in the *Lithuanian Universal Encyclopedia*, which emphasizes that it is a science that studies writing as a reflection of a person's characteristics and mental state. The purpose of graphology is to determine a person's personal characteristics, skills, inclinations, etc. through analysis of his or her handwriting, and graphological methods are used in forensic science to identify from comparative studies a questioned document with samples of the person's handwriting²³. We cannot agree with this statement, since the problem of identifying a person based on comparative analysis of his handwriting is a forensic field, not the field of graphology.

However, in our opinion, in scientific research and expert practice, the handwriting expert would benefit from graphological knowledge in the context of knowing the character of the person being identified, which would allow more precise determination of certain changes in graphism especially in signatures. At the ENFSI conference held in Budapest on November 10-12, 2005, Dr. Lajos Kiss described the training of handwriting experts in Hungary. In the training of handwriting experts, much attention is paid to the acquisition of graphological knowledge. Even an expert handwriter

²⁰ G. Douatte, *Caractère et personnalité par la graphologie*, Amarande, Genève-Paris-Montreal 1992.

²¹ See *Графология*, in Т.В. Аверьянова, Е.Р. Россинская (ed.), op. cit. pp.94-95.

²² *Grafologija*, in: *Lietuvių kalbos žodynas*, <http://www.lkz.lt/?zodis=grafologija&id=11069060000> (accessed 09.03.2024).

²³ A. Nevera, *Grafologija*, in: *Visuotinė Lietuvių Enciklopedija*, vol. VII, Mokslo ir enciklopedijų leidybos institutas, Vilnius 2005, p. 48.

- a graphologist - is invited to court hearings. The statement has sparked considerable debate, but both handwriting experts and graphologists are grounded in Hungarian law. Currently, representatives of the strongest graphological centers of Europe (Germany, Switzerland, Italy, or France) or other continents (the USA, Israel, and others) widely use their knowledge to give opinions about a person's character traits, abilities, or ability to hold certain positions.

Nikodemus Radvilas, a pioneer of handwriting research in Lithuania who wrote extensively about the methodology in his research and the collection of materials for such a study, published a book in 1932 called *How to Know a Man based on his handwriting*, in which he devoted considerable attention to the analysis of handwriting features and their connections with character traits²⁴. Although graphological issues are not among the main topics in the discourses of scholars and handwriting experts, we must point out that this subject is not completely foreign in Lithuania. In 1996, J. Masiulienė published an article on the history of graphology²⁵. In her monograph *Forensic Linguistics*, published in 2006, Renata Ryngevič, while describing the methodological basis of forensic linguistic expertise, also touches on graphology, in which, earlier than in forensics, the links between a person's character traits and the linguistic side of writing began to be studied²⁶.

A handwriting expert with some graphological knowledge can take a more comprehensive look at the research objects presented and use this additional knowledge to draw specific conclusions.

It should not be forgotten that in the study of writing (to a certain extent and signatures) not only graphic analysis is important, but also linguistic (linguistic) and locational analysis (if we do not have a standardized form with the relevant attributes, then the specific meaning is the location of the distribution of the signature).

The structure of the initials (signature) consists of several basic parts (elements). Most often we talk about the monogram, the middle (letter or non-letter) part of the initials, and the swirl (with and without complementary diacritical marks: dashes or dots). In the process of developing this publication, we conducted a source search, looking for information about the features of initials' swirls and the classification of these features.

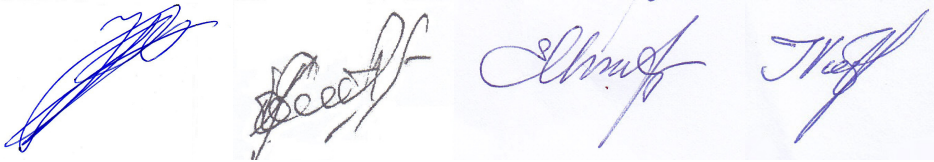
²⁴ N. Radvilas, *Kaip pažinti žmogų iš rašysenos*, Kaunas 1932.

²⁵ J. Masiulienė, *Grafologijos istorijos apžvalga*, in: *Kriminalistikos ir teismo ekspertizės problemos*, Mokslo darbų rinkinys, LTEI, Vilnius 1996, pp. 109-115.

²⁶ R. Ryngevič, *Kriminalistinė lingvistika. Metodologiniai pagrindai ir jų taikymas atliekant ekspertizę*, Monografija, Mykolo Romerio universitetas, Vilnius 2006.

Unfortunately, we have not been able to identify such sources that directly address the characteristics of the final elements of the initials' swirls or signatures. In our opinion, this is an area that requires serious involvement of scholars and practitioners (experts) dealing with the problems of handwriting and signature (initials) research. An example of just one aspect of the complexity of the problem can be seen in the presented initials from our recent experiment. In our opinion, in the presented initials, it is not even easy to determine at which place (location) we can speak of the beginning of the drawing of the swirl

Fig. 3. Experimental paraffins with complex swirl structure



Source: own research.

In initials, the swirl, on par with the monogram and sometimes even to a greater extent, is (can be) one of the most “artistic”, most creative parts of them. Therefore, the purpose of the experiment in question - the authors' third study of signatures - is to learn more about the specifics of swirl formation.

A swirl is the final part of the initials (signature), made with deformed (altered) letters or non-letter elements of different configurations, complexity, and stretch, which serve to make the initials more complex (to make it more difficult to forge). The swirl is usually done at a faster pace than the entire initial, and the variation in the degree of emphasis is particularly pronounced in this part of the initial (signature).

Experiment - conditions and research methods

Participants in the study were first-year students of the Public Security Academy of Michael Romer University and their family members, who voluntarily provided samples of their signatures on questionnaires.

Tab. 1. Original questionnaire template with experimental signatures²⁷

Parašai renkami moksliniam tiriamajam projektui „Parašo formavimosi procesas – šeimos veiksnys“, kurį atlieka prof. dr. Henryk Malewski, Rasa Tamošiūnaitė, prof. dr. Vidmantas Egidijus Kurapka ir prof. dr. Snieguolė Matulienė). Medžiaga bus naudojama apibendrintoje formoje, laikantys asmens duomenų apsaugos.

Pirmąją skiltį pildo studentas/-tė. Kiekvieną sekančią skiltį (2, 3 ir t.t.) pildo asmuo, kuris pasirašo.

1.	Vardas D	5-7 parašai	
	Pavardė Ra		
	Metai (amžius) 19		
	Šeimisinis ryšys Duktė Janukė		
2.	Vardas O	5-7 parašai	
	Pavardė B		
	Metai (amžius)		
	Šeimisinis ryšys močiutė		

Source: own research.

Experimental signatures (initials) were taken between 2022 and 2023. The experiments were conducted in three phases: the first phase included respondents from 26 families (147 people in total), the second phase included respondents from 35 families (151 people in total), and the third phase included respondents from 19 families (109 people in total). The numbering used under the Fig.s in the article will be as follows: the numbering of the first, second, and third experiments will be the first digit in the posted codes: 1, 2, or 3. The family number in the corresponding sample (experiment) will be the second digit (e.g., code 2-13 refers to the second experiment and the thirteenth family), and the family member number will be the third digit in the notation (2-13-4).

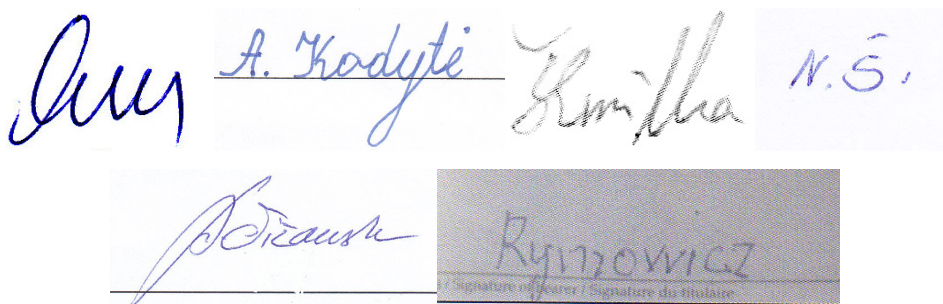
²⁷ Translation of the introductory part of the questionnaire: “The signatures are collected in connection with the scientific research project conducted by Prof. Dr. Henryk Malewski, Rasa Tamošiūnaitė, Prof. Dr. Vidmantas Egidijus Kurapka and Prof. Dr. Snieguolė Matulienė entitled “The process of signature formation - the family factor.” The collected material will be used in a generalized form, respecting the principle of personal data protection.

The first box should be completed by the student(s). Each subsequent one (2, 3, et al.) is filled out by the person who signs.”

The signature collection questionnaires clearly showed the family relationships, names, and age of the respondents. Family relations along the lines of children - parents - grandparents were dominant. Some questionnaires also included people with more distant family ties.

Since this study focuses on the peculiarities of the initials' swirl, it was first necessary to determine what initial number of people (in this experiment) do not have this element in their signatures (initials). Of the 407 respondents, only 24 people ($\approx 6\%$ of the sample) had initials without a swirl. Below are some examples of signatures (initials) without a swirl.

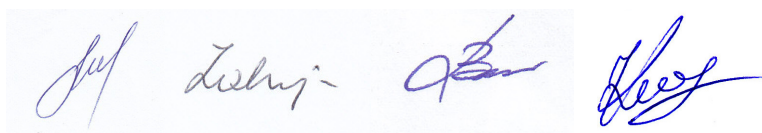
Fig. 4. Signatures (initials) without the end part (swirl)



Source: own research.

The end parts of the initials (swirls) with a simple structure are those that have a single unidirectional line, a single element of a specific shape, or a cyclic continuation of the non-letter grammar of the central part of the signature.

Fig. 5. Signatures (initials) containing the usual (non-fancy) end part (swirl)

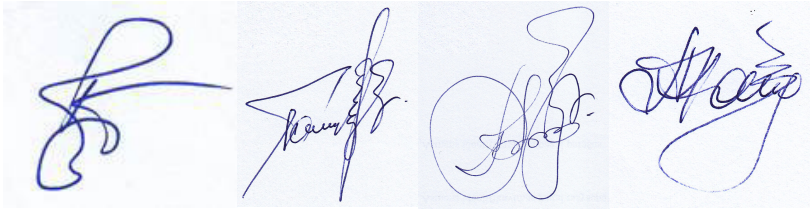


Źródło: badania własne.

Complex swirls have different forms and shapes (curved, turning into angular or wavy, looping with changing direction of drawing, disproport-

tionate extensions of the dash, dashes crossing the longitudinal axes of the signs, etc.).

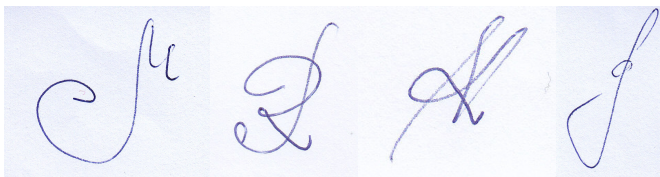
Fig. 6. Signatures (initials) that have complex (fancy) end-words (swirls)



Source: own research.

Creating complex swirls is not a characteristic of signatures (initials) of young people aged 18-19, which is understandable, since the habit of writing and signing is still in its developmental stage. Only with the passage of time and acquired experience in writing can a person more easily control the process, come up with ways to decorate letters, and create elaborate forms and shapes of grammar and their combinations. Over time, these decorative elements become fixed, leading to the individualization of a person's handwriting. A similar process will occur during the formation of the swirl. Initially, the swirl may have a simple (unfancy) form, but over time a person can develop and refine it until it eventually becomes a complex (sophisticated) and difficult-to-fake element.

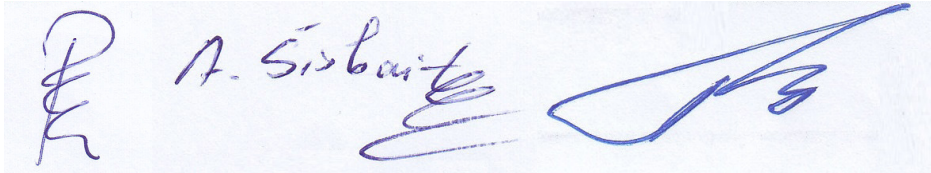
Fig. 7. Signatures (initials) with a minimalist (simple) end part



Source: own research.

Most of the signatures of respondents in our experiment had swirls. It should be noted that the number of simple swirls was much higher, and there was a tendency in our students to imitate the simpler swirls of their parents' initials.

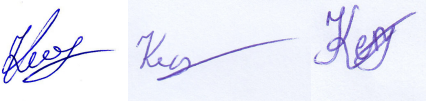
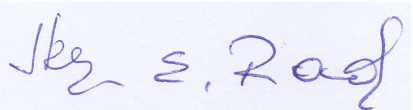
Fig. 8. Signatures (initials) representatives of one family: 3-1-1 (father), 3-1-3 (student), 3-1-6 (grandfather)



Source: own research.

An obvious example of the fact that children prefer signatures with a simpler structure is the family with code 3-5. The children chose the style of their father’s initials’ swirl, which is a simple one-way loop, but did not imitate their mother’s or grandmother’s swirls, which are more complicated to make, because they change the directions of drawing the various elements.

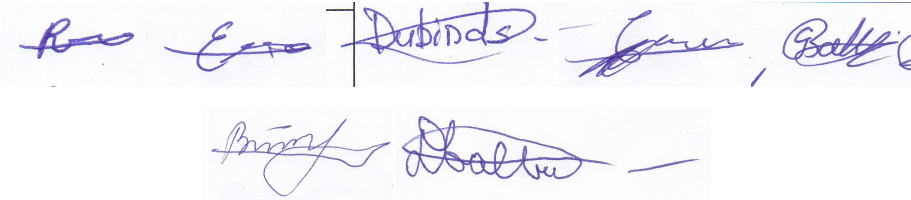
Fig. 9. Signatures (initials) families with code 3-5, in which the young chose the simple style of the father’s swirl as a model, but did not imitate the more complex swirls of the mother and grandmother.

Young people’s chosen swirl patterns	Young people’s unselected swirl patterns.
 <p data-bbox="190 1115 587 1170">Code: 3-5-3 (father); 3-5-4 (son); 3-5-1 (daughter).</p>	 <p data-bbox="640 1130 1091 1157">Code: 3-5-2 (mother); 3-5-5 (grandmother).</p>

Source: own research.

An interesting situation we had in a family coded 3-12, in which in 7 out of 10 family members the swirl is distributed to initials.

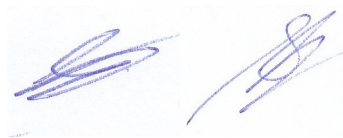
Fig. 10. Specific distribution of swirls in signatures (initials) families with code 3-12



Source: own research.

In the family coded 3-7, the student’s initial is modeled after the mother’s. Neither one nor the other is complex, and the peculiarity is the cyclic arrangement of repeated elements of the swirl on the basic element of the initial.

Fig. 11. Specific distribution of swirls in signatures (initials) families with code 3-7 (3-7-1 - student; 3-7-2 - mother)



Source: own research.

Below is information on the overlap between the young person’s initials’ swirl (signature) style and that of the parents/grandparents in all three experiments.

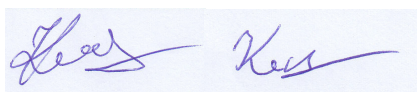
Tab. 2. The way young people use parents'/grandparents' initials' swirl style (109 families)

Another no. of the experiment	Number of families participating in a given experiment	Quantitative characterization of imitation in young people's initials' swirls	Comments
1	19	12 (63%)	
2	35	20 (57%)	In these two experiments, family members only had to sign one time each, which does not make it possible to determine the possible variants of the formation of initials' swirls, but the experimental material we have shows a sufficiently high level of imitation.
3	26	12 (46%)	

Source: own research.

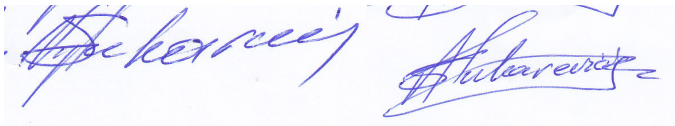
The results of the experiment showed that although young people are more likely to follow their parents' style of making the first part of the signature (initials) when creating their signature, they also often use their parents' swirl pattern to create it. Here we must point out that the imitation of the swirls is sometimes hampered by the more refined style of older family members, so the young person, based on their general graphical features, chooses a simpler or even simplified variant of the swirl.

We would like to present some more findings from the experiment in question. In the signatures (initials) of men, the swirls frequently have a similar shape to the following, shown in Fig. 12. The form of this swirl is most likely an altered (stylized) letter "s" since Lithuanian male surnames usually end with this letter.

Fig. 12. Examples of swirls of the initials of the family with the code 3-5, which were formed from the letter "s" (3-5-3 - father's initials; 3-5-4 - initials of the son)

Source: own research.

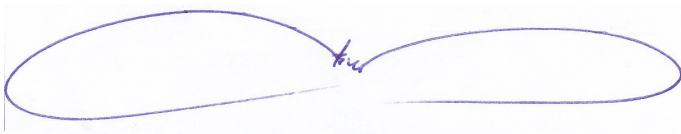
Fig. 13. Examples of family initials’ swirls with code 3-13, which were formed from the letter “s” (3-13-3 - son’s initials; 3-13-4 - father’s initials)



Source: own research.

In the case of men whose surnames end in the letter “a,” the stylized swirl can be in this form, as shown in Fig. 14.

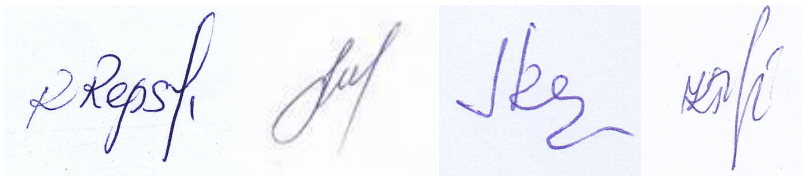
Fig. 14. An example of initials’ swirl of a representative of a family coded 3-19



Source: own research.

Signatures (initials) of women in Lithuanian usually end with the letter “-ė,” and maiden names with the letter “-tė,” so swirls often take the stylized form of these letters.

Fig. 15. Examples of female initials’ swirls in the form of stylized “-ė” or “-tė”



Source: own research.

It is worth noting that the experiment involved first-year law students (social sciences), for whom, unlike students in other majors, the signature (initials) has and will in the future have even greater authentication signif-

icance. For art students, on the other hand, a signature is more a form of expression, which also affects their graphism.

Summary

In total, in three experiments, we surveyed the signatures (initials) of 407 people representing 80 families. The preliminary results of the analysis confirmed our hypothesis that the form and style of a young person's swirl is not infrequently the result of being modeled on the signatures (initials) of older family members. Imitation is a trait that allows one to learn a pattern, to master a skill, which is improved over time through one's work and creativity. It is the final element of the signature (swirl) that to some extent can describe a person's character traits. In this case, we see the possibility of cooperation between handwriting examination experts and graphologists. The benefit of such cooperation may be, first of all, to establish certain diagnostic characteristics of the signing person and, in connection with this, to assist in identification research.

The similarities of signatures (initials) and their final parts among family members, established during the experiment, testify to the patterns young people follow, among other things, in creating the swirls of their signatures. Since writing and signatures in young people are still developing, they most often choose simpler variants of signature structure, including their final elements (swirls), as models. The advantage of this study is that in a few years, we will be able to conduct an analogous experiment with the same students and assess the degree of change in all parts of the signatures (initials).

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Conflict of interest

No

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