

# “For what does thine sanguine divine produce my African † profile?”

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**Abstract.** An analysis and synthesis of portraits of A S Pushkin are used to illustrate the problem of establishing the most probable facial features based on pictorial and verbal portraits of a person. This is an example of an ill-posed inverse problem. The informative anthropometric parameters were drawn from artistic portraits. We carried out a comparison in the space formed of these parameters, taking into account the weight coefficients obtained by analyzing verbal portraits, the artists' competence, and the methods they used. Twelve archive pictorial portraits were employed to produce new portraits using an ‘identikit’ technique whereby elements from different images are combined, and the ‘morphing’ — a superposition of portraits and elements of portraits on one another. Using expert evaluations accounting for the deviation of the anthropometric parameters from the mean values and verbal portraits, three most probable portraits of A S Pushkin were selected, showing the countenance of the poet at different stages of his life.

## 1. Introduction

Aleksandr Sergeevich Pushkin wrote: “We are all lovers of novelty”. Indeed, anything unexpected will involuntarily draw our attention. The work presented below was started as a game but gradually grew into an absorbing biophysical study with elements of art-historic analysis. In the course of the work, we often realized the truth of the words of A P Chekhov: “I have thought that the flair of the artist is sometimes worthy of the brains of the scientist, that both have the same goals,

are of the same nature and, perhaps, with time and the perfection of techniques, are fated to merge all together...” [1].

**The problem statement.** To determine the most probable images of Pushkin's face at different stages of his life on the basis of both verbal and pictorial portraits made during Pushkin's life (1799–1837).

**The method of solution.** A flow chart of the algorithm used to solve the problem is shown in Fig. 1. Using the archive materials available to us, we first constructed a computer database comprising all the known verbal and pictorial portraits. Had Pushkin lived another five years, his descendants might have had a photograph of him. As is known, the first black and white photographs were made by L J M Daguerre and J N Niepse in France in 1839, two years later in England, and after that, in Russia [2]. And if the poet had lived to be 87, as did his friend P A Vyazemskiĭ (1792–1878), then history might even have known a color photograph of Pushkin. But history does not recognize the subjunctive mood. There are, however, numerous artistic portraits and descriptions of the poet's appearance. The true changing face of Pushkin was not easy for artists to portray. We do not even know for sure the color of his hair. His brother, Lev Sergeevich, assured that Aleksandr was always dark-haired. Others (P A Korsakov, O S Pavlishcheva) asserted that he used to be blond in his youth, his hair darkening after 17 years of age. Pushkin himself wrote a joking self-description in French: “I have fresh complexion, fair hair and a curly-haired head” [3, p. 96]. To answer the question ‘what did the poet look like?’ it is necessary to be cautious of memories committed to paper many years later. The memoirists may have jumbled up times and dates, and the

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† This adjective is preferred here to accentuate the African heritage of A Pushkin from the side of his maternal great-grandfather Hannibal. ‘Arapic’, ‘Moorish’, ‘Abissynian’, ‘Ethiopic’, ‘blackamoor’s,’ etc. can also be used. The same lines have been translated by Walter Arndt as follows: “Why does your wondrous pencil strive my Moorish profile to elicit?” (Editor's note.)

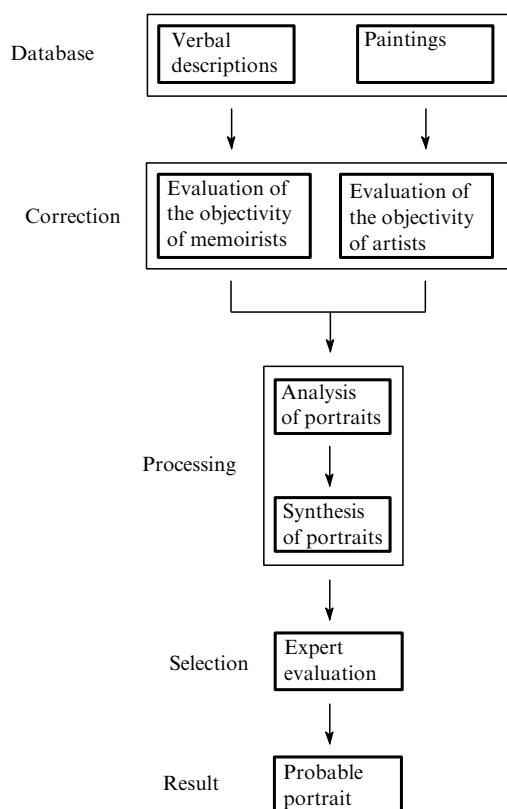


Figure 1. Flow chart of the algorithm used to solve the problem.

greatness of Pushkin's personality would have influenced their attitude — there would be the 'pressure' of the social stereotype. Diary entries of his contemporaries, however

brief, whether the writer was a friend or foe, and the poet's own statements are thus much more valuable to us.

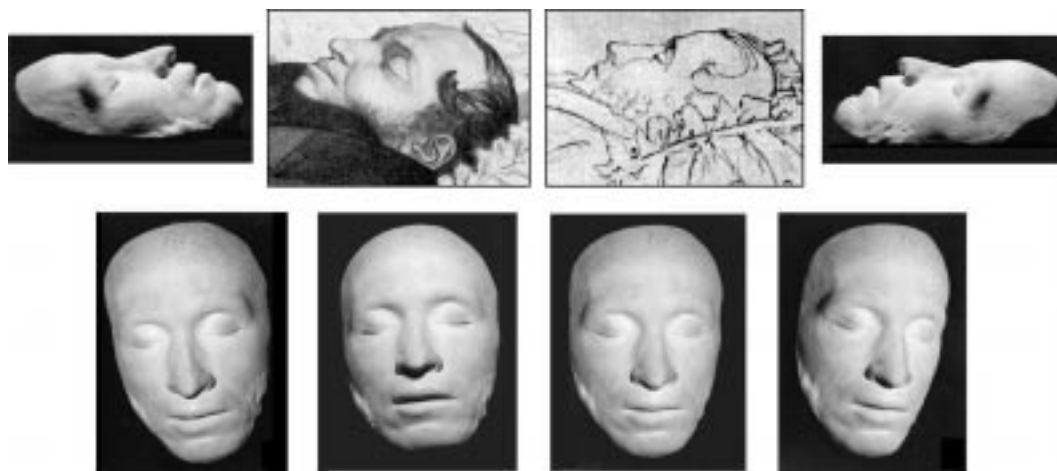
Considered as a whole, the material collected about the poet is more objective, since distortions resulting from the feelings of particular memoirists and painters towards the poet, from their skill, and from the time-inflicted changes in the poet's appearance, compensate one another to some extent. In addition to verbal portraits in the archive, we rested upon pictorial portraits by contemporary artists; sketches made by Pushkin himself in the margins of his manuscripts and in albums of his contemporaries; the poet's death mask, as well as sketches and sculptural portraits made after his death by various artists who may have seen him alive (Figs 2–5).

**The description of the problem.** The procedure of finding the most probable appearance of the poet from archive materials consists in the solution of the problems in the reversed order of cause-effect relationships. Similar problems are encountered in all criminal investigations and in most research fields where the goal is to extrapolate the present to the past — from astrophysics and geophysics to paleontology and medicine.

The solution of such problems is based on advancing hypotheses and verifying them. The mathematical bases of inverse problems were laid by a number of mathematicians (Niels Abel, Henri Poincaré, Jaques Hadamard and others). The root of the complexity of such problems is evident. We shall use the following notation: the distribution of attributes over a set of portraits in the database is denoted by  $G(p)$ ; the operation of correction by  $C(p)$ ; the operations of processing the portraits, the identification of informative attributes and the synthesis of new portraits by  $T(p)$ ; the operation of the choosing of portraits by  $S(p)$ , and, finally, the most probable synthesized images characterizing the appearance of a person



Figure 2. The face of A S Pushkin in paintings and drawings by: 1 — S G Chirikov; 2 — E I Geitman; 3 — E A Engel'gard; 4 — V I Shukhaev (1960); 5 — unknown artist; 6 — V A Tropinin (Elagina's copy); 7 — O A Kiprenskii; 8 — N I Utkin; 9 — Thomas Wright; 10 — Gustav Adolf Gippius; 11 — J Vivien; 12 — I L Linev. All the images were scaled to the same size.



**Figure 3.** The poet's death mask seen at different angles and two drawings, *A S Pushkin on his death-bed*, by F A Bruni and V A Zhukovskii.

by  $B(p)$ . The problem is to find the transformation

$$G(p) \xrightarrow{C, T, S} B(p).$$

In the most general form it may be formulated as the solution of an integral equation of the type

$$G(p) = \int_A K[C(p), T(p), S(p)] B(p) dp, \quad (1)$$

where  $K[C(p), T(p), S(p)]$  is the kernel of the equation, i.e. the function of the operator mapping  $G(p)$  onto  $B(p)$ , and  $A$  is the domain of integration (the content of the database). The confidence level with which  $G(p)$  and the kernel of the equation  $K[C(p), T(p), S(p)]$  are known defines the specifics and singularities of the given integral equation. Such equations may not have an exact solution either because of insufficient information contained in the function  $G(p)$  or in the kernel  $K[C(p), T(p), S(p)]$ . Furthermore, in solving Eqn

(1) one needs to find the derivative  $d[G(p)]/dp$ , which is calculated as a small difference between large variables; this unavoidably leads to the generation and accumulation of the error in the resulting function  $B(p)$ . To reduce the errors, we need to rely on rich statistics (a large archive) to calculate the function  $G(p)$ . Alas, the archive is constrained, so to improve the accuracy we have to advance the hypotheses, thus converting the inverse problem into a direct one:

$$B^*(p) \xrightarrow{C, T, S} G^*(p), \quad (2)$$

where  $B^*(p)$  is a set of hypothetical synthesized images whose parameters  $G^*(p)$  are subsets of the set  $G(p)$ . Then, from the set  $B^*(p)$ , using expert evaluations and verbal portraits, the most probable assembly of attributes is selected for the real face of a person; this choice, however, remains to some extent subjective. The result is inevitably probabilistic. The choice of one particular hypothesis among a set of competing ones is always in doubt and makes one ask: “And pray who are the



**Figure 4.** Sculptural and graphic works made after the death of the poet: 1, 2 and 3 — by sculptor I P Vitali (marble and bronze); 4 — by sculptor A M Opekushin, a model for the head of the monument to Pushkin in Moscow (toned plaster, 1880); 5 — by painter V V Maté (1899); 6 — by painter A Bezlyudnyi (lithography from painting by O A Kiprenskii, 1827); 7 — by painter and sculptor A M Opekushin (1875); 8 — silhouette by È G. (1936).



**Figure 5.** Gallery of self-portraits by A S Pushkin made at different periods of his work: 1 — in the margins of the manuscript of *The Captive of Caucasus* (inventory No. 46, page 6), drawn in May 1821 in Kishinev during his exile in the South; 2, 4, 5, 6, 11 — in the margins of the draft for the novel *Eugene Onegin* (inv. Nos 834, 834, 835, 834, 834), dated May–November 1823, Kishinev — Odessa, during his southern exile; 3 — on a page with notes of Turkish words (inv. No. 698, 1st cover page), same date as above; 8 — on the autographed poem *To N D Kiselev* (inv. No. 905), 14th June 1828, Moscow; 9 — Pushkin's sketch in the album of Ushakova (inv. No. 1723), 1827–1830, Moscow; 7, 10 — two self-portraits on one sheet: the first is Pushkin's view of himself before his exile; the second, after his return (inv. No. 715), September–October 1826, Moscow; 12 — one of his last self-portraits, from the draft of a letter to V A Sollogub (inv. No. 343), 20–28 February 1836, St. Petersburg [4].

judges?" We can only state that the images selected from among the synthesized set do reflect the appearance of the poet with maximum probability.

## 2. The database of verbal portraits

The database of verbal portraits was constructed from the diaries and memoirs of contemporaries of the poet:

(1) "...Sasha † was ever so clumsy and shy, curly-haired with a dark little face, not too comely, but with most lively eyes from which sparks would fly..." (from the memoirs of E P Yan'kova) [3, p. 44].

(2) "Pushkin was unsightly, but his face was expressive and soulful; he was short of stature, but slender and unusually robust and well-proportioned..." (from the memoirs of the poet's brother, L S Pushkin) [3, p. 186]. Pushkin's height in adulthood is well-known — 166.6 cm (2 arshins and 5.5 vershoks) [4, note 135] and [6, caption under a drawing of

the poet made by G G Chernetskiĭ: "Drawn from life, 15th April 1832. Height: 2 arshins and 5 vershoks and a half"]).

(3) "The ugly descendant of Negroes" (1820, Pushkin himself, in the poem *To Yur'ev*) [4, p. 340].

(4) "A boozier, ... irascible to the extreme, ... always absent-minded, ... spoilt from childhood by praise and flattery, ... nothing agreeable ... nor attractive in his manners, in the Lyceum he indulged in profligacy of all kinds... an uninterrupted chain of bacchanalia and orgies... Pushkin was of the lowest depravity... in him reigned only two passions — the satisfaction of carnal desires and poetry. In both he went a long way" (from the memoirs of a fellow pupil at the Lyceum, Baron M A Korf) [3, p. 99].

(5) Prince P A Vyazemskii, commenting on the notes of M A Korf, said that "It was true that he was irascible and easily annoyed, but when his pride was not hurt he was most polite and attractive, to which his numerous friends are testimony... there was nothing vulgar about him, still less depraved... In love it was not sensuality that prevailed but most likely a poetic inspiration, to which his poetry is rather a proof..." [3, p. 99].

(6) I I Pushchin (Pushkin's friend): "... He was either too daring or too shy, always at the wrong time, which made things worse. To genuinely love him, one had to look at him with that utmost benevolence that knows of and perceives all the faults of a friend's character and his other shortcomings, and accepts them, finally even coming to love them. This happened between us quite soon and of itself" [3, p. 100].

(7) "His timidity was visible in all his movements..., he was very varied in his ways, sometimes loudly jocular, sometimes full of melancholy, sometimes timid, withdrawn, endlessly courteous, sometimes tiresomely boring, and one never knew what his mood might be a minute later..., he could not hide his feelings, always expressed them sincerely and was handsome beyond words when something nice moved him. When he chose to be courteous, his speech was brilliant, witty and fascinating beyond comparison..., he was inexpressively charming when he chose a topic and took it upon himself to entertain society" (from the memoirs of Anna P Kern of her meeting with Pushkin in June 1825 in Trigorskoe) [5, p. 59].

(8) "Finally, you must picture the very figure of Pushkin. The High Priest of the Arts that we expected to see was of average height, almost short, fidgety, with long hair a bit curly at the ends, unpretentious, with quick lively eyes, a quiet pleasant voice, in black tails and waistcoat buttoned up tight with a carelessly tied tie. Instead of the high-flown tongue of the gods we heard a speech that was plain, clear, ordinary and at the same time poetic and captivating" (12th October 1826, from the memoirs of the historian M P Pogodin) [5, p. 165].

(9) "Pushkin's looks have changed very much. Awful black side-whiskers have given his face a kind of devilish expression. Otherwise, he's still the same. Just as lively and quick, going in a moment from merriment and laughter to reverie and deep thought" (from a letter of fellow Lyceum pupil P L Yakovlev, November 1826) [5, p. 167].

(10) "God, having given him a unique genius, didn't reward him with an attractive appearance. His face was expressive, of course, but some anger and mockery overshadowed that spirit that was in his blue, or rather glassy, eyes. His Moorish profile, handed down from his mother's side, didn't make his face any handsomer. And added to that, his awful side-whiskers, disheveled hair, claw-like nails, short stature, affected manners, his impertinent view of women, whom he distinguished by his love, his wild ways made worse

† Sasha — endearing shorter form of the full name Aleksandr. (Note by the translator.)

by upbringing and his unbounded self-esteem" (from the memoirs of A A Olenina, 1828) [5, p. 181].

(11) "This is a man of short stature, and at first glance you see nothing special about him. If you study his face from the chin upwards up to his eyes, you'll search in vain for a sign of poetic gift. But the eyes will certainly arrest your gaze: there you'll see the gleam of the fire which burns in his verse, full of strength and feeling" (the censor Nikitenko, circa 1827) [5, p. 414].

(12) "This man gains a lot in your opinion when you know him better" (Sofi Mikhaïlovna Del'vig — the wife of Pushkin's friend, fellow Lyceum pupil, Del'vig. A letter to a friend, May 1827) [5, p. 190].

(13) "The great Pushkin, a small child" (A A Del'vig) [5, p. 217].

(14) "I see him, as if it were now, lively, simple-mannered, roaring with laughter, full of motion, even fidgety, with wonderfully big, clear, bright eyes that seemed to reflect all the beauty of nature, and with gleaming white teeth, cared for as Byron's. He was neither of dark complexion nor had dark hair, as some insist, but was of quite fair skin and had curly chestnut hair. His countenance held something of the African, but nothing to justify his verse — "the unsightly descendant of Negroes". On the contrary, he had nice features. He was carefully dressed and groomed as a true man of the world" (from the memoirs of M V Yuzefovich, an aid-de-camp of General Raevskii, who had met Pushkin in the army in the Caucasus in 1829) [5, p. 250].

(15) "In the newspaper... they say that I am far from handsome and that my portraits are too flattering. I made no response to the personal offence, although I felt it deeply (Pushkin himself, from "Refutation of criticisms", 1830) [4, p. 341].

(16) "I can repeat what my late nanny had said: I was never handsome, but I used to be young" (Pushkin himself, from a letter to his wife, 1835) [4, p. 340].

(17) "Pushkin, the writer, has a charming manner of speech, without pretensions, lively and fiery. You cannot imagine an uglier face, half monkey, half tiger. He comes from an African race, and a trace of it remains in his complexion and wild stare... Next to her (referring to Pushkin's wife) his ugliness is even more striking, but when he speaks, you forget what he lacks to be beautiful" (from the diary of Countess D F Fikel'mon — General-Field-Marshal Kutuzov's granddaughter, written in French) [7, pp. 33–34].

(18) "Here they want to fashion a bust of me. But I don't want it. Then my Moorish homeliness will be immortalized in all its deathly immobility" (Pushkin himself, from a letter to his wife, 1836) [4, p. 343].

(19) "A special smile of his own, in which a sharp sneer and endless good-humor were so strangely combined" (from the memoirs of the young Count V A Sollogub after the death of the poet) [5, p. 414].

(20) "Pushkin was not handsome a bit: too dark-faced, with irregular features, but you couldn't imagine a more appealing, more lively, more expressive face and a more agreeable, more harmonious voice, as if tailor-made for his verse" (note of a chance stranger, 1835) [5, p. 415].

(21) "At that moment, a yellowish, dark-skinned man with dark hair walked in. He had rather thick, dark side-whiskers and lively, laughing eyes..., when Pushkin smiled his charming smile, his broad scarlet lips revealed rows of beautiful teeth of striking whiteness" (note of a provincial who happened to meet the poet at

A F Voëikov's house in 1836, two months before Pushkin's death) [5, p. 415].

(22) "At first glance, his appearance seemed plain. Of medium height, lean, with small features on a dark face. Only when you looked intently at his eyes you could see their thoughtful depth and a kind of nobility — the eyes you would never forget... In my opinion, the engraving made by Utkin from the portrait by Kiprenskii renders his appearance best of all. In all the other copies his eyes are too wide-open, almost bulging, the nose prominent — this is wrong. He had a small face and wonderful head in proportion, with not too thick, curly hair" (from the memoirs of I A Goncharov, when as a student he saw Pushkin on a visit to Moscow University, 27 September 1832) [5, p. 345].

(23) "What mother could conceive a man whose genius was so full of power, freedom and grace? Now a savage, now a European, now Shakespeare, now Byron, now Ariosto and Anacreon, he'll always remain Russian..." (from a letter of Princess Zinaida N Volkonskaya, 29 October 1826) [5, p. 156].

Among verbal portraits, descriptions 4 and 10 by Baron M A Korf and A A Olenina are distinguished by their hostility to the poet, and there were reasons for this. Pushkin's classmate at the Lyceum, M A Korf, was the son of a Prussian officer who had taken Russian nationality. He was a pious, pedantic, orderly and ambitious man. In all his time at the Lyceum, not once was he reproached for questionable behavior. The character reference given to him by the Lyceum tutors in 1812 mentions that "... prudence and timidity prevent him from being truly sincere and free". It is evident that by character and personality Pushkin was the exact opposite of Korf. The frivolous jokes of Pushkin's youth and his association with debauched hussars repelled the young Korf from the poet and his circle forever; that is why many years later, after Pushkin's death, the dignitary M A Korf still produced such a verbal portrait [3].

The cause of the hostile description written by A A Olenina was female pride and caprice. Pushkin was in love with the charming Annette, daughter of the President of the Academy of Arts A N Olenin, and dedicated to her this wonderful verse † in a reply to P A Vyazemskii's verse "Chernye ochi" ("The black eyes"):

But, admit yourself, there's no compare  
To the eyes of Olenina mine!  
Such pensive in them genius  
And such childlike simplicity,  
And such languorous expression,  
And such comfort and dreaming.  
She casts them down with the smile of Lel —  
In them the triumph of modest grace;  
She lifts them — an angel of Raphael,  
Thus contemplates a deity.

(Linear transl. by G Michael)

However, this verse infuriated Annette, first because it was in a letter to someone else, and second because Pushkin, not yet betrothed, already dared to refer to her as 'mine'. Olenina not only turned down the poet (as Pushkin's friend Ekaterina Ushakova would later pun, playing on 'olen' being Russian for 'deer', "the poet was left with 'deer's horns'"), but also wrote this unflattering verbal portrait (description 10). The remaining descriptions are generally rather balanced, and the features of the poet's countenance common in them are not unexpected. Unlike Pushkin's contemporaries, we have an image of his appearance formed by 150 years of social stereotyping. We recognize him by his elongated eyes, his

curls and his side-whiskers, by his straight nose, protruding chin, his thick lips and his swept back forehead. Thus we have known him from childhood in formal portraits, pencil sketches or schematic self-portraits from the margins of his own manuscripts. One description by a contemporary refers to a portrait which has survived to our days, mentioning the resemblance of Pushkin's face to the engraving by N I Utkin, made from the portrait by O A Kiprenskii (description 22). This information is highly useful, but it would be obviously wrong to base the choice of the most likely countenance of the poet on a single statement.

### 3. The database of pictorial portraits

Figure 2 shows paintings, drawings and sketches of A S Pushkin executed by contemporary artists (both professionals and unidentified amateurs). He looks different in every picture. To make comparing easier, all these images were transformed to the same scale on a computer.

The two surviving portraits of Pushkin at the Lyceum are scarcely alike. The first (Fig. 2, image 1), made at the beginning of his life there, and the second (Fig. 2, image 3) — towards the end. The second portrait was executed by E A Èngel'gard, the Director of the Lyceum: it is difficult to match this dandy young man with the tousled adolescent of the first portrait drawn by his tutor, S G Chirikov. Only the large forehead and the sharp glance at the viewer are the same. It is possible that the Lyceum director would have wanted the pupils entrusted to him to look smart and trim in a German style. The third portrait of the same period (Fig. 2, image 2) is an engraved author's copy made by E I Geĭtman from portrait 1.

Other portraits represent the poet in maturity. The most famous are two portraits, one by V A Tropinin (Fig. 2, image 6, the best copy of A P Elagina is shown here) and one by O A Kiprenskii (Fig. 2, image 7). Both artists graduated from the St. Petersburg Academy of Arts and were professionals of the highest class. Their portraiture techniques were quite dissimilar but complementary. The paintings by Vasilii Andreevich Tropinin (1776–1857) were renowned for sculptural shape and vivid detail, and those by Orest Adamovich Kiprenskii (1782–1836), for romanticism and deliberate prettiness with a touch of classicism. Kiprenskii's portrait of Pushkin gives a notion of how a major art personality was traditionally portrayed at the beginning of the 19th century. The poet himself commented the portrait as follows:

You show me myself as if in a mirror,

But this mirror flatters me.

(*Linear transl. by V Kisin*)

The portrait by Kiprenskii became a classic, and was copied in various techniques even during the poet's lifetime. The social stereotype of Pushkin's appearance grew to be based, to a great extent, on this very portrait. An engraved copy of the portrait and numerous impressions of it were made by the eminent master of engraving, Nikolai Ivanovich Utkin (1780–1836) (Fig. 2, image 8). Although his engraving was a repetition of Kiprenskii's original, Utkin managed to make it even more expressive due to varied strokes and, possibly, his own ideas of the poet's character. The skill of at least these three professional artists is beyond doubt. Image 9 in Fig. 2 was made by another famous engraver, Thomas

Wright; running ahead of the story, we note that the anthropometric parameters of this portrait are the closest to the mean values obtained from all the portraits. This portrait has been reproduced many times in publications of the works of the poet. The appearance of Pushkin in portraits 7, 8 and 9, executed in the same period when he was 28 or 29, seem to the onlooker to differ only very slightly, but nevertheless the exact values of the anthropometric parameters are rather varied.

Regarding the image in portrait 5, there is an ongoing controversy. Portrait 4 is a well-known recent work (1960, by the artist V I Shukhaev) [17, p. 283]. This portrait is included especially for comparison, to illustrate the existence of a particular branch in the Pushkin portraiture tradition. This line begins with the work of I L Linev (image 12) and ends with this one (image 4). The point is that after Pushkin's death he was usually painted either after the paradigm laid down by Kiprenskii or, to a lesser extent but still quite frequently, by Tropinin. The portraiture introduced by J Vivien, still less the one by Linev, practically never served as imitation models. However, ever since K A Somov painted his portrait of Pushkin in 1899, imitations of Linev's realistic undecorated likeness of Pushkin started to compete successfully with socially stereotyped paintings after Kiprenskii and Tropinin. The countenance of Pushkin in the well-known painting by I K Aivazovskii, *Pushkin by the sea. Farewell, unfettered elements!* (1868) [17, p. 140], where the figure of the poet was painted by I E Repin, clearly follows the trend started by Linev.

Portraits 4, 5, 10–12 noticeably differ in the representation of the face from portraits 6–9. Two hypotheses may be proposed: either these dissimilarities result from the abilities of the artists, or Pushkin himself had changed over time.

We also had drawings of the poet's face on his death-bed at our disposal, as well as photographs of his death mask at various angles (see Fig. 3). There are five known drawings of the dead Pushkin [16]. Three of them were made by professionals: F A Bruni, A N Mokritskii and A A Kozlov; and two by amateur painters V A Zhukovskii and A N Strugovshchikov. As examples, two drawings are shown in Fig. 3: one by a professional (F A Bruni) and the other, by an amateur (the poet V A Zhukovskii). For a number of reasons, these portraits can only approximately reflect the countenance of the poet before death. After death, the muscles of the face relax and the tissues at zero blood pressure contract, which 'sharpens' the features. These changes are individual and depend on the structure of facial tissues and their mass, and on the density of the blood circulatory system. In his time, the anthropologist and sculptor M M Gerasimov (1907–1970) studied these issues when creating a technique of plastic reconstruction of the face from the skull [8]. However, not knowing the face of a man during his life, it is not possible to precisely reconstruct it from his skull. Though it may be recognizable, the image of the person remains an approximation. This problem, just as the reconstruction of a person's appearance from portraits attempted here, is, strictly speaking, ill-posed.

Figure 4 shows photographs of busts and portraits of A S Pushkin made after his death. Therefore, to a great extent, they inevitably reflect the individuality of the sculptors and artists who created the images without a sitter, the influence of the already existing portraits, and the awareness of the poet's time-proven social significance and of his tragic end. Many of these artists were eminent masters, and several of

† A S Pushkin "Her eyes" (1828) in *Complete Collection of Works in 10 vols*, 4th ed. Vol. 3 (Leningrad: Nauka, 1977) p. 63.

them had seen the poet during his life. For example, Ivan Petrovich Vitali (1794–1855) was a major sculptor-monumentalist. It was he and his apprentices who made the sculptures for the famous St. Isaac Cathedral in St. Petersburg (more than 300 statues and bas-reliefs) and for the Georgievskii Hall in the Great Kremlin Palace. His busts of Pushkin, though romantic by style just like the portrait by Kiprenskii, still give a realistic image of the model (Fig. 4, images 1–3). Of course, Aleksandr Mikhaïlovich Opekushin (1838–1923) could not have seen Pushkin, but in creating the memorials to Pushkin in both Moscow (1880) and St. Petersburg (1884) he certainly acquainted himself with all the portraits of Pushkin made during his lifetime (see Fig. 4, images 4, 7). We must also mention Vasilii Vasil’evich Maté (1856–1917), an eminent engraver of the late 19th century, who could not have seen the poet either but also created an interesting likeness (see Fig. 4, image 5).

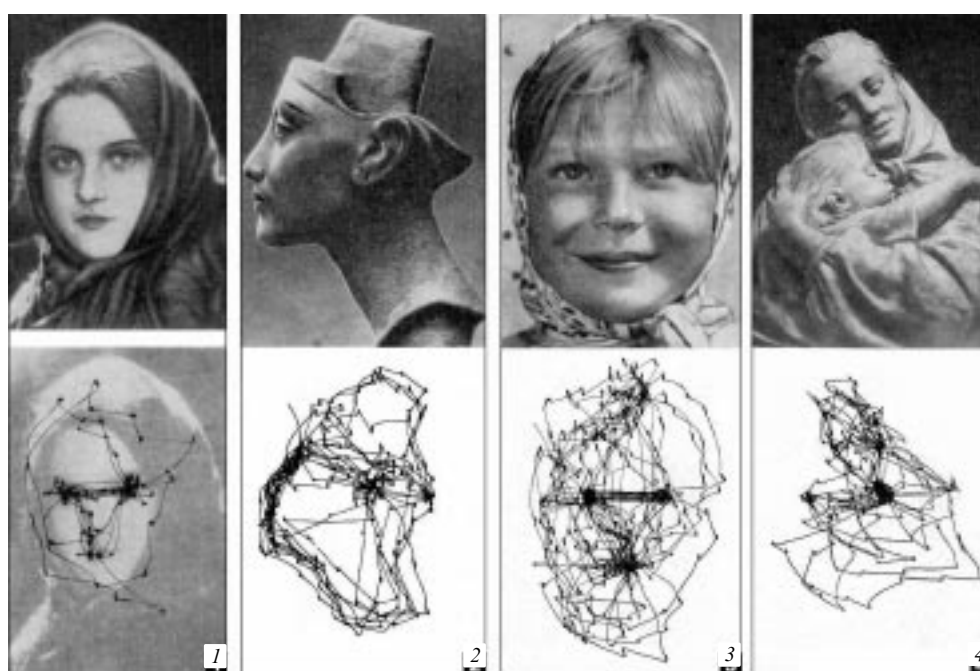
In the margins of his manuscripts, Pushkin often drew his own face. He is left over fifty such drawings [4]. Figure 5 presents a few typical ones. Since both at home and at the Lyceum, the young Pushkin was taught the fundamentals of drawing, and it is known that he was a quite capable pupil, these self-caricatures provide additional information about his appearance. All the drawings show the characteristic profile: the swept-back forehead and a prominent lower part of the face.

#### 4. Analysis of the portraits

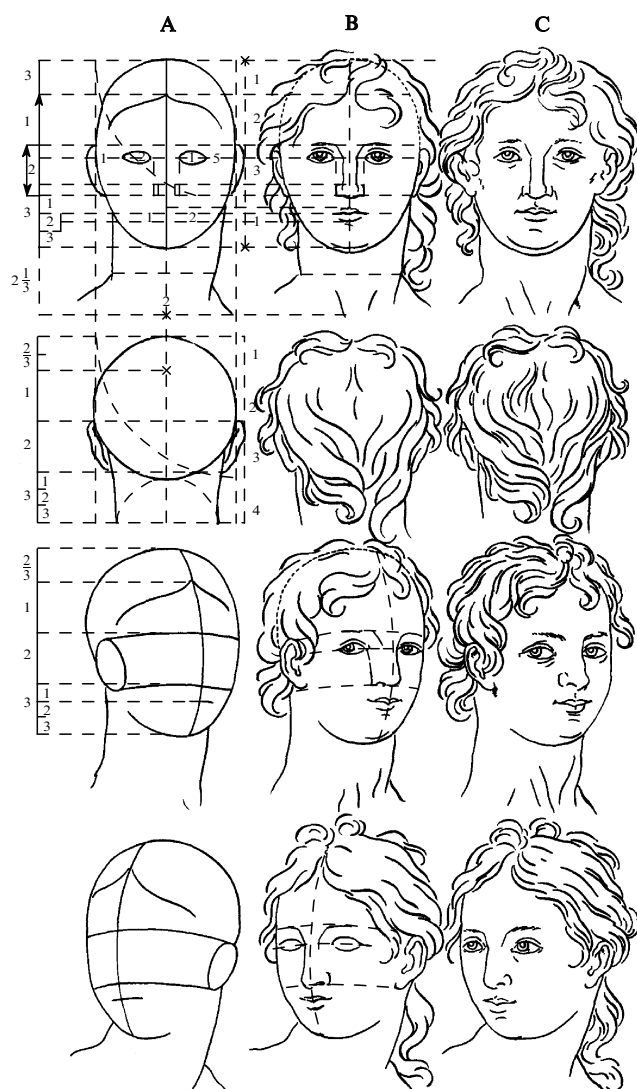
**Informative elements of the portraits.** Which features of a portrait usually invoke the most interest in the observer? The answer to this question may be found in the work of A L Yarus, carried out in the Institute of Theoretical and Experimental Biophysics (Pushchino) at the end of the 1950s and the beginning of the 1960s. He recorded the trajectory of

light spot reflected from a tiny mirror attached by a special suction cup to the eyeball. This experiment enabled Yarus to photograph the trajectory of motion of a subject’s eye when examining an image. The experiments proved that the eye is detained by certain elements for longer times, and by others less or not at all. Figure 6 shows several images and respective eye motion traces from the book by Yarus [9]. It is evident that indifference to or interest in elements of the picture are affected in no way by the richness of details of which the element is formed. The density of the ‘light spot’ traces is an indicator of the information value of the elements of the image for the observer. It is clear from the traces shown in Fig. 6 that the greatest importance is attached to the eyes, the nose, the triangle made up from the eyes and the tip of the nose, the position of the mouth, and the shape of the lips. The outline of the face attracts the eye significantly less.

**Drawing techniques of the Pushkin period.** The drawing of portraits would begin with the geometry of the face (seemingly the least informative element) to which the observer pays little attention when examining the model. Geometrically, a face is a three-dimensional ellipsoid, a kind of stage on which the composition of the portrait is set. In the book by J D Preissler (1728), Director of the Nürnberg Academy of Fine Arts, which was translated into Russian and published in the middle of the 18th century under the title *Preisslerovskaya Risoval’naya Kniga* (The Preissler Drawing Book), can be found the then accepted algorithm for producing a graphical portrait. It is easily understood in terms of today’s computer graphics (Fig. 7). Preissler’s book achieved success with the Russian Academy of Arts founded in 1757. Throughout the second half of the 18th century and the first half of the 19th, it was a students’ textbook and was used by those who portrayed Pushkin from life. We must emphasize an important fact mentioned by Preissler in the section “On the movement of the head”: “It is necessary to



**Figure 6.** Test images and the trace of the motion of subject’s eye, freely examining the picture for a prescribed time interval: 1 — face of a young woman (1 min); 2 — image of the Egyptian sculpture of Queen Nefertiti (2 min); 3 — face of a little girl (3 min); 4 — image of the sculpture *My child* by G L Petrashevich (2 min) [9].



**Figure 7.** The sequence of strokes in drawing a head, from *The Preissler Drawing Book* (1728), one of the essential teaching manuals at the Russian Academy of Arts in the 18th and 19th centuries, used by artists who portrayed Pushkin from life.

consider where the head is facing. It should especially be noted that, the more upward the head faces, the more the upper part is diminished”. For a mathematician, this is a transformation from one coordinate system to another, expressed through the angles of rotation of the axes. Taking this into account is important in calculating the anthropometric parameters in portraits for comparison between themselves.

### 5. Correction formulae for calculating anthropometric parameters on the basis of portraits made under varying foreshortening of faces

On measuring anthropometric parameters (such as the distance between the eyes, the size of the eyes and lips, the length of the nose, the angles from the tip of the nose or from the middle of the chin to the edge of the eyelid, etc.) it is essential to allow for the shape of the head and the foreshortening of the face portrayed. On turning the head,

the projection of these distances into the plane of the portrait changes.

We know that in projective geometry, the invariant property of figures projected onto a plane by rays issuing from a common point is the ratio of collinear line segments. For example, a line segment divided into three equal parts by equidistant points  $a - b - c - d$ , gives an invariant ratio of the lengths of the parts:  $ac \cdot bd / ad \cdot bc = \text{const}$ . This relationship remains fixed on transformation. Such a transformation differs from the affinity in which the projection is produced by parallel rays. For affinities, the ratios of the adjacent collinear line segments themselves remain constant:  $ab/bc = bc/cd = \text{const}$ . If the subject has not a flat but a curved surface, with locally varying curvature, then the transformation in projection substantially depends on topology. In this case, the affine and projective relations are not satisfied since the collinear line segments may be deformed on the curved surface (stretched, compressed, or twisted, as in a ‘Hall of Mirrors’). However, the sequential order of points  $a, b, c, d$  remains constant for such transformations, i.e. permutations are impossible. When the curved surface is smooth, as a sphere is, then the invariance of the projective geometry holds, and the transformation of an image from such a surface onto a plane may be done using spherical projective geometry. A graphic work by M C Escher (Fig. 8) is a good illustration of the distortion on making a projection onto a sphere.



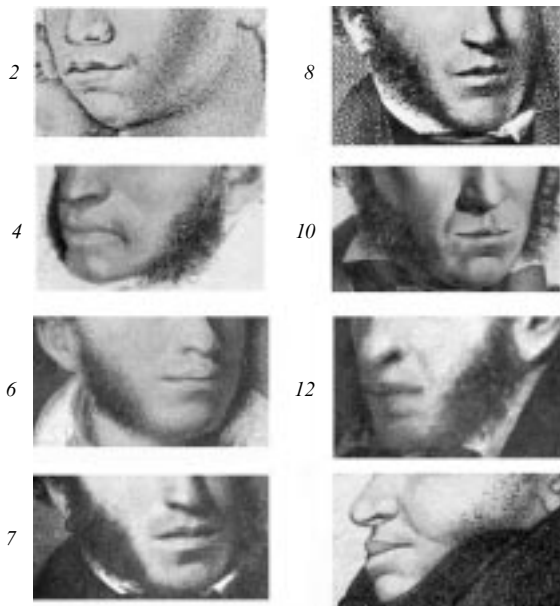
**Figure 8.** Drawing by M C Escher *Hand with reflecting globe* [from M C Escher, *The Graphic Work* (Berlin: Benedikt Taschen Verlag GmbH, 1990)].

Much research into the change of projections onto curved surfaces has been done over the last decade in connection with the creation of robots able to recognize spatial configurations [10, 11]. We have also studied problems in this field while creating computer methods for quantitative analysis of spatial microscopic biostructures [12]. We shall examine how the projections of lines on the portraits change depend-



ing on the shape of the head, and what corrections must be introduced into angles and distances measured on the portraits compared. It is easiest to calculate the corrections if we approximate the head by a sphere. It is then possible to apply the standard well-known formulae of spherical geometry.

However, a spherical head is probably an exception rather than a rule. As seen from Fig. 9, the greatest spread in the images of Pushkin is found in the lower part of his face, his chin and lips. This part of the skull distorts the sphericity of the face, transforming the base, upon which the relief of the face is set out, into the surface of a triaxial ellipsoid. It is possible that this peculiarity posed some problems for the artists of the time. The correction formulae in this case may be obtained by transforming the ellipsoid to a sphere, with the sphere surface being equal to that of the ellipsoid. Thus we calculate the necessary numerical corrections that make it possible to implement successive transformations when calculating the parameters: from an ellipsoid viewed at a certain angle to the equivalent sphere, then correcting the sphere for the foreshortening, and then transforming it back to the ellipsoid viewed at a new angle (Fig. 10).



**Figure 9.** Pushkin's lips and chin in various portraits. The numbers correspond to portraits in Fig. 2. The last image is from Fig. 3.

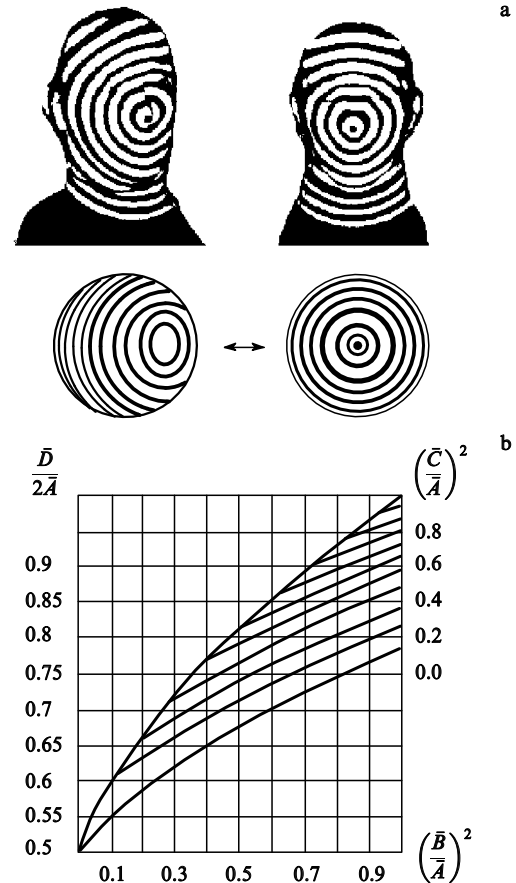
The equation for the ellipsoid in space has the form

$$\frac{x^2}{A^2} + \frac{y^2}{B^2} + \frac{z^2}{C^2} = 1, \quad (3)$$

where  $A$ ,  $B$ , and  $C$  are the semiaxes of the ellipsoid. If we construct a plane tangent to any point  $N(x_0, y_0, z_0)$  on the surface of the ellipsoid, the equation of this plane is

$$\frac{xx_0}{A^2} + \frac{yy_0}{B^2} + \frac{zz_0}{C^2} = 1. \quad (4)$$

The direction of the vector  $ON$  (where  $O$  is the origin of coordinates) is defined by the directional unit vector  $\mathbf{e}$  ( $\cos \alpha, \cos \beta, \cos \gamma$ ), where  $\alpha$ ,  $\beta$ , and  $\gamma$  are the angles between the vector  $NO$  and the Cartesian axes  $x$ ,  $y$ , and  $z$ . For brevity, we denote the cosines by  $\alpha$ ,  $\beta$ , and  $\gamma$ , so that  $\mathbf{e} = (\alpha, \beta, \gamma)$ . We



**Figure 10.** Mapping of the relief of a head to a sphere with the equivalent surface: (a) illustration of the transformation of an ellipsoidal head to a spherical head rotated in space by a given angle; (b) chart for calculating the diameter of the equivalent sphere from measurements of the ellipsoid axes.

denote the length of the vector  $ON$  by  $\rho$ . The value of  $\rho$  may be found from the standard formulae of analytical geometry as the distance between two points, one of which is at the origin and the other on the surface of the ellipsoid. We thus have

$$\rho = \frac{1}{(A_1^2 + B_1^2 + C_1^2)^{1/2}}, \quad (5)$$

where

$$A_1 = \frac{x_0}{A^2}, \quad B_1 = \frac{y_0}{B^2}, \quad C_1 = \frac{z_0}{C^2}.$$

According to trigonometry, we have  $\alpha^2 + \beta^2 + \gamma^2 = 1$ . For a vector joining the origin and a point on a tangential plane (the plane of the portrait), the cosines of the angles are

$$\alpha = \frac{\rho x_0}{A^2}, \quad \beta = \frac{\rho y_0}{B^2}, \quad \gamma = \frac{\rho z_0}{C^2}. \quad (6)$$

Equations 6 connect the coordinates of this plane with the orientation vector of the ellipsoid (head) in space, defined by the cosines  $(\alpha, \beta, \gamma)$ . Since the point  $N(x_0, y_0, z_0)$  belongs to both the plane of the portrait and the surface of the ellipsoid, it also satisfies the equation of the ellipsoid (3), therefore

$$\frac{x_0^2}{A^2} + \frac{y_0^2}{B^2} + \frac{z_0^2}{C^2} = 1. \quad (7)$$

Substituting relations (6) into equation (7) we obtain

$$\rho^2 = A^2 \alpha^2 + B^2 \beta^2 + C^2 \gamma^2. \quad (8)$$

If now we construct a second tangential plane at a distance  $D = 2\rho$  from the first tangential plane, and recast the directional cosines as variables from Cartesian coordinates to polar coordinates, i.e.  $\alpha = \sin \phi \cos \theta$ ,  $\beta = \sin \phi \sin \theta$ , and  $\gamma = \cos \phi$ , then the value  $D(\phi, \theta)$  that takes into account Eqn (8) becomes

$$D(\phi, \theta) = 2(A^2 \sin^2 \phi \cos^2 \theta + B^2 \sin^2 \phi \sin^2 \theta + C^2 \cos^2 \phi)^{1/2}. \quad (9)$$

Further, we may transform the ellipsoid to the equivalent sphere of the same surface using Eqn (9). Then the surface of the ellipsoid is  $\int^{(F)} D(\phi, \theta) df$ , and the surface of the unit sphere  $\int^{(F)} df$ , where  $F$  is the domain of integration with respect to the angles  $\phi$  and  $\theta$  over the surface. Given that the elementary surface element on a sphere of unit radius is  $df = d\phi d\theta$ , we obtain the mean diameter of the equivalent sphere  $\bar{D}$  as the ratio

$$\bar{D} = \frac{\int^{(F)} D(\phi, \theta) df}{\int^{(F)} df}. \quad (10)$$

Having substituted  $df = d\phi d\theta$  into expressions (9) and (10), we obtain

$$\bar{D}(\phi, \theta) = \frac{2}{\pi} \int_0^{\pi/2} \int_0^{\pi/2} D(\phi, \theta) d\phi d\theta. \quad (11)$$

Owing to the symmetry of the ellipsoid, we only need to integrate over a single octant. On integrating with respect to  $\theta$  (supposing that the angle within a single ring  $\phi$  does not vary) and assuming  $A > B$ , we arrive at

$$\begin{aligned} \int_0^{\pi/2} D(\phi, \theta) d\theta &= 2(A^2 \sin^2 \phi + C^2 \cos^2 \phi)^{1/2} \\ &\times \int_0^{\pi/2} \left( 1 - \frac{(A^2 - B^2) \sin^2 \phi}{A^2 \sin^2 \phi + C^2 \cos^2 \phi} \sin^2 \theta \right)^{1/2} d\theta. \end{aligned} \quad (12)$$

With notation

$$K^2 = \frac{(A^2 - B^2) \sin^2 \phi}{A^2 \sin^2 \phi + C^2 \cos^2 \phi}, \quad (13)$$

the integral part takes the form

$$\int_0^{\pi/2} (1 - K^2 \sin^2 \theta)^{1/2} d\theta = E(K, \theta). \quad (14)$$

This is a full elliptical integral of the second kind. Now introducing the first factor of expression (12) into the integral sign and taking into account expression (14), we obtain

$$\bar{D} = \frac{4}{\pi} \int_0^{\pi/2} (A^2 \sin^2 \phi + C^2 \cos^2 \phi)^{1/2} E(K, \theta) d\phi. \quad (15)$$

This integral, although known, has not been tabulated [13]. To determine the diameter of the equivalent sphere from Eqn (15), we may use an expansion to a hypergeometric series or a numerical solution. In pre-computer time, G Bach devised a chart of numerical corrections calculated using

Eqn (15) [14]. With this chart (see Fig. 10) we can clarify the algorithm for introducing corrections for the calculation of anthropometric parameters. To find the corrections, it is necessary to know the ratios of the axes of the head ellipsoid. We chose to derive them from the death mask of the poet. The measurements on the death mask gave the mean ratios squared  $(\bar{C}/\bar{A})^2 = 0.51$  and  $(\bar{B}/\bar{A})^2 = 0.655$ , where  $\bar{A}$  is half the face height,  $\bar{C}$  is half the face width, and  $\bar{B}$  is half the distance on the head from the brows to the back of the head. To find  $\bar{D}/2\bar{A}$ , one must trace vertically from the value  $(\bar{B}/\bar{A})^2 = 0.655$  on the chart horizontal axis to the intersection with the curve that corresponds to  $(\bar{C}/\bar{A})^2 = 0.51$ , and then from this point horizontally to the axis  $\bar{D}/2\bar{A}$ , where we obtain the value  $\bar{D}/2\bar{A} = 0.85$ . The diameter of the equivalent sphere for the same surface is then

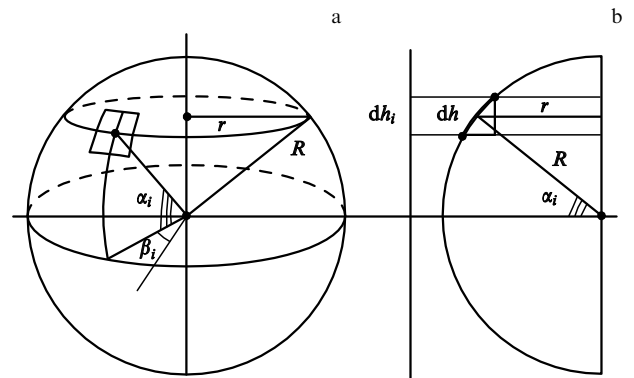
$$\bar{D} = 1.7\bar{A}. \quad (16)$$

Using the diameter of the sphere so corrected, and the formulae of spherical geometry, it is possible to generate all rotations of the sphere, and then for the selected rotation angle calculate the foreshortened length of the line segments on the surface of the sphere, and the magnitudes of their projections onto the plane of the portrait. The position of each local region  $i$  on the sphere in polar coordinates is identified with the radius  $R_i$  of the sphere and two angles: the position angle  $\alpha_i$  and the foreshortening (azimuth) angle  $\beta_i$ . A simple geometric diagram (Fig. 11) yields the formula

$$r = R \sin(90 - \alpha_i) = R \cos \alpha_i, \quad (17)$$

where  $r$  is the radius of the circular section of the sphere for a position angle  $\alpha_i$ , and  $R$  is the radius of the sphere; in view of Eqn (16),  $R = 0.85\bar{A}$ . Further, it is easy to find the projection of facial relief onto the plane of the portrait. It is evident that for rotations of the relief positioned on the spherical surface, it is necessary to replace  $R$  in expression (17) with its new incremented value  $R + \Delta R$ , where  $\Delta R$  is the height of the elevated part of the relief. In this case, we define relief as the protruding parts of the face — the nose, the chin, the arches beneath the eyebrows, etc. For instance, the projection of the horizontal length of the local region  $i$  onto the plane of the portrait, located on a circle of radius  $r$  and defined by the position angle  $\alpha_i$  and the foreshortening angle  $\beta_i$ , is

$$dl_i = dl \frac{\cos \beta_i}{[1 + 1.33(\tan \beta_i/2)^2]^{1/2}}, \quad (18)$$



**Figure 11.** Coordinates of relief elements on a sphere (a) and their projections onto the plane of the portrait (b).

**Table 1.** Main anthropometric parameters of the face in the portraits.

Artist (from Fig. 2)	Foreshortening (degree)	Angular parameters (degree)				Vertical parameters (rel. units)						
		$\alpha_1$	$\Delta\alpha_1$	$\alpha_2$	$\Delta\alpha_2$	$l_0$	$l_1$	$l_2$	$l_3$	$l_5$	$l_4/l_0$	$l_4/l_5$
E I Geitman 2	+30	46	+5	24	+3	1	0.57	0.39	0.19	0.44	0.46	1.05
V A Tropinin 6	-15	42	+2	22	+1	1	0.58	0.40	0.18	0.44	0.41	0.93
V A Shukhaev 4	-5	37	-3	20	0	1	0.53	0.37	0.16	0.47	0.37	0.78
Unknown artist 5	+50	35	-5	18	-3	1	0.54	0.34	0.19	0.47	0.32	0.71
N I Utkin 8	-15	37	-3	22	+1	1	0.59	0.42	0.18	0.42	0.40	0.76
Thomas Wright 9	-15	41	+1	22	+1	1	0.54	0.39	0.17	0.46	0.40	0.88
O A Kiprenskii 7	-15	44	+4	22	+1	1	0.57	0.40	0.17	0.43	0.41	0.96
G A Gippius 10	-15	38	-2	20	-1	1	0.56	0.35	0.12	0.47	0.37	0.79
I L Linev 12	+50	43	+3	23	+3	1	0.54	0.38	0.17	0.46	0.42	0.93
Mean over all portraits	—	40	—	21	—	1	0.56	0.38	0.17	0.45	0.40	0.87
Death mask	0	41	—	23	—	1	0.52	0.37	0.14	0.48	0.42	0.88

**Key:** foreshortening in column 2 — the angle of rotation of the head from facing: (+) clockwise, (–) counter-clockwise;  $\alpha_1$  — the angle between the central line of the face and the line connecting the tip of the nose with the outside edge of the eyelid;  $\alpha_2$  — the angle between the central line of the face and the line connecting the chin with the outside edge of the eyelid;  $\bar{\alpha}_1, \bar{\alpha}_2$  — the mean values of the angles  $\alpha_1, \alpha_2$  over the whole ensemble of portraits;  $\Delta\alpha_1 = \alpha_1 - \bar{\alpha}_1$  and  $\Delta\alpha_2 = \alpha_2 - \bar{\alpha}_2$  — the angular deviation from the mean value;  $l_0$  — the distance from the chin to the line joining the eyes (the basis size);  $l_1$  — the distance from the chin to the tip of the nose;  $l_2$  — the distance from the chin to the line of the mouth;  $l_3$  — the distance from the line through the eyebrows to the line through the eyes;  $l_4$  — the distance between the outer edges of the left and right eyelids;  $l_5$  — the length of the nose (from the tip to the line through the eyes).

where  $dl_i$  is the horizontal dimension of the portrait, and  $d/l$  is the horizontal dimension on the sphere.

Professional artists often used not the affine but a spheroidal projection of the face onto the plane of the portrait, consciously distorting the dimensions on the portrait according to the laws of spherical projective geometry. In this case, expression (18) is simplified. For the horizontal and vertical dimensions of the selected  $i$ th element on the sphere we obtain the following simple transformation formulae:

$$dh_i = dh \cos \alpha_i, \quad (19)$$

$$dl_i = dl \cos \beta_i, \quad (20)$$

where  $dh_i$  and  $dl_i$  are the dimensions on the portrait,  $dh$  and  $dl$  are the dimensions on the sphere (on the face), and  $\cos \alpha_i$  and  $\cos \beta_i$  are the cosines of the position angle and foreshortening angle, respectively.

## 6. Formation of the space of attributes of a person's appearance

To analyze the portraits of Pushkin, we used 23 anthropometric parameters describing the shape of the head and the proportions of the face. The basic selection included 14 portraits (12 in Fig. 2 and two images from Fig. 3). The dimensionality of the space analyzed was given by 322 parameters. On the basis of 14 sets of parameters corresponding to individual portraits, the mean values were calculated for each of the parameters, and portraits with the largest deviations from the mean value were singled out. Table 1 demonstrates 120 of the 322 parameters measured and their mean values. The portraits 1, 2 and 4 in Fig. 2 deviate more than others in angular parameters, specifically in the angle the central line of the face makes with the line connecting the tip of the nose and the outside edge of the eyelid ( $\alpha_1$ ), and the central line of the face makes with the line connecting the chin and the outside edge of the eyelid ( $\alpha_2$ ). In portraits 1 and 2, the angles  $\alpha_1$  and  $\alpha_2$  are exaggerated by 12–14%, and in portrait 4 they are reduced by about the same amount. In other words, the face in portraits 1 and 2 looks wider than in portrait 4. The angular parameters of the portraits of Pushkin correlate well

with his life stages: the years spent at the Lyceum, the culmination of his poetic powers (1826–1830) and the last troubled years of his life (1830–1837). This is natural, since the face is usually wider in childhood than in maturity. Closest of all to the aggregate mean over all the portraits with respect to the angle  $\alpha_1$  is portrait 9 by Thomas Wright. The deviation is only 2–2.5%. As for the angle  $\alpha_2$ , portrait 5 is the closest, showing practically no deviation.

Now we turn to the classics. The deviation of the angle  $\alpha_1$  pertinent to portrait 6 by Tropinin (the copy of Elagina) from the mean value is less than that on the Kiprenskii † portrait 7. The deviations of  $\alpha_1$  for these portraits are 5 and 10%, respectively, whereas they are close to the mean value for  $\alpha_2$ .

The basis for calculating the vertical proportions was taken to be the distance between the tip of the chin to the midpoint between the eyes ( $l_0$ ); all other parameters characterizing the coordinates of the mouth ( $l_2$ ), the tip of the nose ( $l_1$ ), the eyebrows ( $l_3$ ), and the distance between the eyes ( $l_4$ ) were normalized relative to this basis size. In addition, we calculated the ratio of the distance between the eyes to the length of the nose ( $l_4/l_5$ ). The analysis showed that of all the portraits, engraving 9 by Thomas Wright was the nearest of all to the mean values of the length parameters (as we saw for the angular parameters, too). The deviations from the mean were: position of the mouth +3%, that of the tip of the nose –4%, while that of the eyebrow line coincided with the mean value more or less exactly. The difference between portraits 5 and 8 according to the position of the mouth are maximal, deviating on both sides of the mean by 18%. The maximum deviation for the position of the tip of the nose on the portrait 5 in comparison with portraits 9 and 12 is about 10%, while the line of the eyebrows for portraits 1 and 10 deviates by about 50%, etc.

Let us return to the classics. For the T-portrait and the K-portrait, the deviation of the position of the mouth from the mean is +5%; the position of the tip of the nose deviates by +4% for the T-portrait and by +2% for the K-portrait; the position of the eyebrow line on the T-portrait deviates by +6%, while on the K-portrait it corresponds to the mean

† Hereinafter for brevity we refer to Tropinin's portrait as the T-portrait, and Kiprenskii's, the K-portrait.

position. In other words, on the T-portrait the nose is a little uplifted and the forehead and chin are somewhat sloped in comparison with the K-portrait. If we now look at Pushkin's self-portraits (Fig. 5, images 3, 6, and especially 11, 12) we see that Tropinin's rendering of the characteristic features of the poet's face is closer to Pushkin's own ideas of his appearance. We must again stress the fact that mean values of anthropometric parameters (and, consequently, deviations from them) depend strongly on the selected sample of portraits. Therefore, it is worth comparing the portraits anthropometrically on a pairwise basis.

During quantitative computer analysis of anthropometric parameters of Pushkin's portraits, our attention was drawn to an important psychological aspect of the visual recognition of a human face: minor distortions of the proportions of the face even by a few percent are noticed by the observer and alter his perception of the face. It is clear that human faces (for example, those of the mother, the father and others around a person) are the first images that a child learns to recognize. In its brain, the perception of their characteristic features is reflected with the greatest subtlety.

It is remarkable that the transition to a new anthropometric space with a new set of images requires additional training. For example, it is well known (and many know it by experience) that when a European first finds himself among Asian faces, he has difficulty telling them apart: "all Chinese faces look alike". However, within a few hours, he can distinguish individual faces according to a new set of attributes specific of the race. The observer gets hold of a different set of distinctive attributes for identifying faces. A slightly different but similar situation arises when we come across faces that are very much alike: the faces of twins. To begin with, we cannot distinguish which is which, but then, by comparing them, we find subtle, significant differences. Later, on meeting them separately, we can identify each twin.

Furthermore, analyzing the parameters of the poet's portraits and comparing them to those of his death mask we found that the vertical dimensions ( $l$ ) on the dead face were reduced by around 10–20% (see Table 1). For example, parameters describing the position of the mouth, tip of the nose, and eyebrow line on the T- and K-portraits deviate from those of the death mask by 8, 9–11 and 21–29%, respectively, and the deviation of the mean parameters of all the portraits from those of the death mask was 3, 7 and 35%, respectively. The angular parameters  $\alpha_1$  and  $\alpha_2$  were also changed, but not significantly (3–7%). After death, the poet's features became 'sharper'.

## 7. Synthesis of new images by 'combination' and 'superposition' of portrait elements

Obviously, artists had the greatest difficulty capturing the most informative features of Pushkin's face: his eyes and the lower part of his face (see Figs 12 and 9). The artists, whether by chance or on purpose, would either try to 'force' the real face before them to fit an average European standard or, on the contrary, would accentuate as far as possible the very personal features which they discerned. A S Pushkin, according to his contemporaries, had elongated blue eyes. Our measurements showed that the mean ratio of dimensions of his eyes  $a/b$  is 1:3, but hardly on any of the contemporary portraits are the dimensions of eyes at exactly this ratio. For the average eye of a European, this ratio is approximately 1:2.5. Apparently, this answers for the great variety in the



**Figure 12.** Pushkin's eyes in various portraits. Parameters characterizing the shape of the eye are defined at the bottom of the figure.

geometry of Pushkin's eyes in different portraits (see Fig. 12). Some artists distended Pushkin's eyes to look more 'European' (portraits 6, 7 and 10), others ignored the standard (2, 4, 12). The scatter in ratio values reaches 25%. The T-portrait shows deviation by +7% (increased horizontal elongation), the K-portrait, by –16%, almost matching the European standard ( $a/b = 1:2.6$ ). Pushkin drew himself with elongated eyes (see Fig. 5).

The shape of the lower part of the face (see Fig. 9), the prominent chin and thick lips, was so much unlike standard European features that contemporary artists, their successors (see Fig. 4) and likewise the poet himself (Fig. 5, image 11) faced a problem: how to make the image resemble the original and yet conceal "his unattractive appearance". Nevertheless, in portraits 2, 4, 6, 12 (Figs 2 and 9) and in the sketch *Pushkin on his death-bed* (Fig. 3), this difficult and nonstandard part of the poet's face is adequately portrayed. In portraits 3 and 10, however, in contrast to the T-portrait (Fig. 2, image 6), the sweep of the forehead — present in all Pushkin's self-portraits (Fig. 5) — has almost disappeared.

New hybrid portraits of the poet were obtained by combination of the portraits and fragments of different portraits. The synthesis was done by an 'identikit' technique with an exhaustion of variants, including superposition ('morphing') of whole portraits and their elements. We thus obtained seven new 'hybrids' for each pair of portraits of different painters. As an illustration, we shall limit ourselves to just a few of the more unusual ones.

Figure 13 shows four authentic and eight synthesized portraits. The first column shows four authentic portraits from Fig. 2 that were used for producing new images. The two



**Figure 13.** Originals (first column) and several examples of portraits synthesized by ‘identikit’ technique. The fractions in the margins indicate which fragments come from which originals in Fig. 2.

remaining columns show novel portraits synthesized by an ‘identikit’ technique and a combination of ‘identikit’ and ‘morphing’. The line segments and figures in the margins indicate which portraits and at what sections were combined to produce new ones. The portraits are numbered as their originals are in Fig. 2. The first row illustrates how modifying the shape of eyes changes the appearance of the face. The second row shows the effect of permutation of large details of the face. (The last image in the third row lets you see how the face in the T-portrait would look with the headdress from portrait 5 on). We shall leave it to the reader to examine and

compare the portraits and to decide how substitutions and permutations affect an image.

## 8. Expert analysis and selection

Selecting from a set of synthesized portraits was the most difficult stage of all. None of our contemporaries know what the poet really looked like. Still, from the gallery of synthesized portraits of Pushkin at 27–29 years of age, one portrait won the most experts’ points, namely, that produced by direct ‘morphing’ of the portraits by O A Kiprenskii and V A Tropinin (Elagina’s copy). It is shown in the center of Fig. 14. In selecting this portrait, we relied on the proximity of its anthropometric parameters to the mean over all portraits of Pushkin at that age; on the correspondence of this image to some descriptions from the archive of verbal portraits (descriptions 21 and 22); the clear presence of the characteristic shape of Pushkin’s chin and lips, stemming from the poet’s Abyssinian (Ethiopian) descent; very high skills of the artists (Kiprenskii and Tropinin) who painted the portraits from which the morph was made, and their complementary portrait techniques. It is possible, however, that the experts were subconsciously influenced by the social stereotype of the poet’s appearance, so that they were unable to deviate from the accepted standard when choosing one from among the set of synthesized portraits. Furthermore, the attractiveness of an image obtained by averaging may depend upon a psychological factor that became known only recently [15]. Traditionally, a standard face was believed to be unattractive. The poet himself thought so and wrote with irony (the main draft for the poem *The Bronze Horseman*):

We meet hundreds like him everywhere,  
His face and his mind  
Indistinguishable from those in our crowd.

(*Linear transl. by V Kisin*)

However, recent experimental research has shown that it is the average appearance which has the greatest appeal to most people. We made a random selection of several dozen black-and-white photographs of different men and women. Each photograph was divided into local areas, and then the corresponding areas were averaged using the ‘morphing’ technique. The result was ‘average’ male and female faces. In both cases, the majority of respondents preferred the averaged face to the real faces. ‘Average eyes, ears and mouths’ were all judged prettier than individual ones. Yet another interesting discovery was that the more faces were used to produce the average image, the more attractive the



**Figure 14.** Experts’ selection of synthesized portraits of Pushkin at different ages. From left to right: Pushkin at 15–16 years of age, at 27–28, after 35.

result was to observers of the opposite sex. There is only one drawback to such images, namely, these ‘completely average’ faces do not exist.

So decide for yourself, whether the averaged portrait of Fig. 14 shows the true appearance of the poet, or the selection was determined by subconscious processes in experts’ minds. Perhaps one of the images in Fig. 13 is closer to the original? Or maybe all the portraits are good likenesses? Perhaps they reflect different expressions of the versatile face of a passionate and lively man. Probably, the fascination of Pushkin’s face, its features irregular to a European eye but full of expression, lay in the gaze of his changing eyes that could appear blue or black at times, full of “caustic laughter and endless kindness”. But no one was sufficiently astute, or perhaps of sufficient talent, to make a substantive generalization, and capture either in words or in a portrait that special radiance which emanates from an exceptional man.

From the three likenesses of the young poet (Fig. 2, images 1–3), we synthesized 24 new portraits and selected one, obtained from images 1 and 2, using weight coefficients for the superposition (Fig. 14, left). Two factors were considered in the selection. Firstly, it had to be possible for the face of young Pushkin to arrive, as he grew up, at the mature face that we had already selected. Secondly, the fact that the publisher N I Gnedich had included portrait 1 (Fig. 2) in the first edition of *The Captive of Caucasus* in 1822, perhaps because of its likeness to the original. The chosen synthesized portrait is very similar to image 1 and matches both the verbal descriptions of Pushkin at that age (descriptions 1 and 2) and young Pushkin’s words about his appearance at this time: “I have fresh complexion, light-brown hair and a curly-haired head”.

Finally, we tried to construct a likeness of the poet in his later years (after 1830). The experts chose the image shown in Fig. 14 at the right. This was obtained by an ‘identikit’ technique from portraits 4 and 11 (see Fig. 2). This selection was determined by the fact that if we rotate the averaged image of Fig. 14 by 15° in addition to the original foreshortening, we get a very similar but somewhat younger-looking face. The expert choice is confirmed by verbal portraits of the older Pushkin (descriptions 11, 20 and 21) and matches his own drawings (Fig. 5, images 5, 6, 8, 10–12).

## 9. Conclusions

In order to appreciate Pushkin’s work, we do not really need to know what he looked like or what his contemporaries thought about his appearance. Today Pushkin is a national symbol of culture and history. To Russians he probably means more than Shakespeare or Byron do to the English, or Goethe to the Germans. Furthermore, his generalized schoolbook image (perhaps not quite faithful to the original) leads a life of its own, oblivious of time. The poet’s anniversary provided us with an opportunity, using modern computer techniques for object recognition, to take a look at the social and psychological problem of the perception and depiction of Pushkin by artists, and to attempt to recreate his true appearance.

However, conveying the dynamics of the poet’s versatile face by static means is an almost impossible task. This is what N A Polevoi, the owner of *The Moscow Telegraph*, wrote in his paper on the subject (No. 9, pp. 33–34, 1827): “The Russian artist Tropinin recently finished a portrait of Pushkin. Pushkin is portrayed *en trois-quart*, wearing a

robe, leaning on a little table. The likeness is astonishing, although it seems that the artist was not fully able to capture the poet’s quick glance or lively expression. True enough, Pushkin’s face, so tangible and expressive as to be captured by any painter, is at the same time so mercurial, so elusive that we can hardly expect just one portrait of Pushkin to give a true impression of him. Indeed, a genius so fiery, brimming with life each time something new impresses him, must have a changing expression, which is the very soul of his face. Is this not why the very best portraits of Byron are said to be so unlike each other, although all have something in common that reflects the poet?” (cited from the book [16]).

We find more unexpected evidence of this in Pushkin’s own words in description 18 and in the short verse addressed to the artist George Dawe [4, p. 340]:

Why does your wondrous pencil strive  
My Moorish profile to elicit?  
Your art will help it to survive,  
But Mephistopheles will hiss it.

[(*Pushkin Threefold: Narrative, Lyric, Polemic & Ribald Verse. The Originals with Linear and Metric Translations by Walter Arndt* (Ann Arbor: Ardis, 1993)].

Sixty years later, cinematography would be invented. But even this technical medium would probably have been unable to capture the true nature of the poet. Only the entirety of the events in the life and creative work of a man of such caliber as Pushkin can show, as if in a mirror, his true-to-life image.

## 10. Appendix. The history of Pushkin’s portraits

**The fate of Tropinin’s painting.** Its owner, S A Sobolevskii, did not send it to the exhibition in St. Petersburg, as N A Polevoi wrote in *The Moscow Telegraph*, but gave it to Avdot’ya Petrovna Elagina to make a smaller copy. Elagina’s copy was 26 by 21.5 cm. Pushkin saw it, and his contemporaries valued it highly. This copy, before it turned up at the Pushkin House in St. Petersburg, had an almost detective story spun around it. Thrown out by S A Sobolevskii as a ‘poor’ imitation, it was picked up. Elagina’s granddaughter, M V Beer kept it and displayed it in 1899 at the jubilee exhibition dedicated to Pushkin’s 100th anniversary. Everyone believed it to be the authentic Tropinin painting. The original, meanwhile, had, since the mid 1850s, been in the hands of the scholar and director of the Moscow Archive of the Ministry of Foreign Affairs M A Obolenskii who had bought it in a Moscow pawnbrokers for 50 roubles. From 1889 to 1937, the authentic Tropinin portrait was in the Tret’yakov Gallery, and since 1937, in the St. Petersburg Pushkin Museum. It became widely known in 1860, when photographic reproductions were made and circulated throughout Russia [16].

**The Kiprenskii portrait.** It is generally believed that Pushkin approved the Kiprenskii portrait for its likeness, and these lines by Pushkin are cited to prove this point of view:

I see myself as if in a mirror,  
But this mirror flatters me.

Certainly, the resemblance on the Kiprenskii’s portrait did not go unnoticed: “The Kiprenskii portrait, drawn from Pushkin, is unusually lifelike” (N A Mukhanov wrote in a letter to his brother, 15 June 1827). “This is the poet Pushkin. Don’t look at the signature: having seen him even once alive, you’ll immediately recognize his penetrating eyes and the mouth, which lacks only its incessant quivering: this portrait was painted by Kiprenskii” (from the diary of St. Petersburg

University professor and censor A V Nikitenko, 2 September 1827, concerning the exhibition of the Academy of Arts, which opened on 1 September). “Without venturing to enumerate the beauties of this composition by Mr. Kiprenskii, we shall say only that this is the living Pushkin” (F V Bulgarin, reviewing the exhibition in the newspaper *The Northern Bee*, 1827).

However, if we read Pushkin’s poem addressed to Kiprenskii in full, then his sarcasm with regard to his painted likeness clearly shows through. It makes us recall the old joke: “When one of the Roman Popes told the artist who painted his portrait that it didn’t look like him at all, the artist replied, readily: ‘Never mind, in a hundred years, it will’.”

To confirm this idea, let us quote Pushkin’s gratitude to Kiprenskii in full:

Light-winged favourite of fashion,  
Though not Briton nor French,  
Dear conjuror, once more you have created  
Myself, nursling of Muses pure,  
And I laugh at the grave,  
Released forever from mortal bonds.  
Myself I see as in a mirror,  
But this mirror does flatter me.  
It speaks that I debase not  
The bias of the great Aonids.  
So to Rome, Dresden and Paris  
Henceforth my aspect shall be known.

(*Linear transl. by G Michael*)

Pushkin turned out to be right — the social stereotype of the poet’s appearance grew on just that portrait by Kiprenskii and on similar ones (by Utkin, Wright, and later Maté and Bezlyudnyi). In 1837, after the death of the poet, the demand for his portraits grew rapidly, and all the engravings and lithographs were quickly bought up. It is curious that the ratio of prints was 1:9, namely, for every portrait by Tropinin, there would be nine prints made from the Kiprenskii painting. This is how the social stereotype of the poet’s appearance was born.

The fate of the Kiprenskii portrait is well known. After the death of its owner, Pushkin’s friend A A Del’vig, in January 1831, Pushkin bought it from his widow for 1000 roubles. The portrait was handed down in the family of Pushkin’s eldest son until 1916, and has been in the Tret’yakov Gallery ever since.

**The portraits by J Vivien, P F Sokolov and I L Linev.** The portrait by Vivien (image 11) and a miniature portrait [17, p. 78], very probably also painted by Jean Vivien, show Pushkin at the age of about 28 (the miniature is dated 1827; the portrait is undated). It is possible that these paintings are closer to the original than those in the Tropinin–Kiprenskii series. In the portraits by J Vivien, as in that by Gippius (1829), Pushkin is portrayed without the romantic gleam. J Vivien’s line in depicting the poet was clearly continued by G G Myasoedov in a well-known large painting called *Pushkin and his friends listen to recitation by Mickiewicz in Princess Z Volkonskaya’s parlour* [17, p. 168]. We find the older Pushkin (1836–1837) in the portraits by P F Sokolov, T Wright and I L Linev. The former two keep with the Tropinin–Kiprenskii–Utkin line. “The ardent and inspired Pushkin was already no more. There was a kind of melancholy in his face” (P Kh Grabbe intimated [16, p. 50]). “Towards the end of his life some baldness had begun to show and his hair had ceased to curl” (P V Nashchokin noted [16, p. 50]). “I am sure that concern for the future of his family, his debts, and endless worrying about survival were

the main cause of the irritability which he showed in the events that were to lead to his death” (N M Smirnov [16, p. 51]). According to his contemporaries, P F Sokolov never embellished his models.

The history of the creation of the portrait by Ivan Loginovich Linev (image 12) deserves special notice. It is full of riddles, differing versions and mysticism. We do not know when the portrait was painted, and who commissioned it. However, it does portray Pushkin in the very last period of his life. According to a theory born in the late 1960s — early 1970s, the poet V A Zhukovskii, probably around January–March 1836, invited both Pushkin and Linev to dinner in order to promote the painting of this portrait [18]. S M Kulikov believes that a certain illegible note written in Pushkin’s hand around 1835–1837 was possibly addressed to Zhukovskii and contained the following text: “I send you my ugly mug”. Some suggest that Pushkin was referring to his portrait by Linev.

Yet another mystic version is in existence that the model for the Linev portrait was A S Pushkin lying dead in his coffin [16]. This is based on an attempt to reconstruct the events of 29–30 January, 1837. It is reliably known that I S Turgenev brought a lock of hair, clipped from the head of the dead poet by Nikita Kozlov, to the house of Linev. All the rest are mere assumptions. It is possible that on hearing the news of Pushkin’s death, I L Linev went to the house on the river Moika to pay his respects, and spent two days by the coffin, ‘absorbing’ the image of the poet’s dead face. He then ‘brought the image to life’ in his painting, but stuck to the features of the dead face that were so vivid in his memory: flattened, with a sunken chin and thin, smoothed-down lips. This, however, is only a hypothesis, and one that is unlikely ever to be either confirmed or refuted. Still, the face of Pushkin in the portrait by Linev is quite close by its anthropometric parameters to the poet’s death mask. Whatever the true story of Linev’s portrait may have been, it had certainly started a new branch in the gallery of Pushkin’s portraits.

The portrait by Linev, being very different from all others, started yet a third branch in the way the poet was painted by later artists. The first branch goes from Tropinin and Kiprenskii to Sokolov and Wright, continued by N N Ge (1875), V A Serov (1899), M P Klodt (1899), V Taburin (1899), V V Maté (1899), K F Yuon (1950) and others; the second, starts from J Vivien, followed, among others, by G G Myasoedov (1905–1907) and P Ya Pavlinov (1924). The third branch, started by Linev, was clearly continued in portraits by K A Somov (1899), V N Masyutin (1919), H P Dmitrievskii (1925), Yu L Obolenskaya (1925), A A Suvorov (1937) and others up to V I Shukhaev (1960). The latter branch should also include the well-known romantic painting by I E Repin and I K Aivazovskii, *Pushkin by the sea. Farewell, unfettered elements!* (1887), in which Repin, who painted Pushkin in the joint painting, clearly followed the lines of the portrait by Linev. However, in the painting by Aivazovskii alone, *Pushkin on the shore of the Black Sea* (1868), the poet bears more resemblance to the Tropinin–Kiprenskii portraits [17, 18].

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