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Visual Images in Radiography: Pareidolia as a Useful Tool for Physicians and Artificial Intelligence

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ABSTRACT

This article explored the role of pareidolia in radiography and its potential in improving diagnosis and medical personnel training. Pareidolia is the phenomenon of perceiving familiar patterns in random objects, such as faces on the moon's surface and animal figures in clouds. In radiography, pareidolia can manifest as recognizable patterns in medical images. This enables radiographers to identify abnormalities and improve their diagnostic skills.

This work aimed to evaluate pareidolia caused by the interpretation of X-ray images and determine its potential applications.

From June to December 2023, a competition was held to create a dataset of pareidolic illusions. Thirty-one individuals participated, including medical imaging specialists who had access to radiographic images. Images from nine additional participants were obtained outside the competition. Overall, 71 images were received. Participants uploaded images using a form on Yandex Forms. Data quality was ensured by clearly defined inclusion and exclusion criteria.

Data analysis revealed that people most frequently perceive human faces, animal snouts, and the heart symbol. These findings indicate the possibility of further research. This article discusses the potential applications of pareidolia in developing neural networks for automated medical image analysis and in educational activities that stimulate creative thinking and association.

Moreover, the article emphasizes the importance of ongoing research in this area to develop effective diagnostic tools and educational programs by expanding the evidence base.

Keywords: pareidolia; artificial intelligence; metaphoric signs in radiology.

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Зрительные образы в рентгенологии: парейдолия в помощь врачам и искусственному интеллекту

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АННОТАЦИЯ

Статья посвящена исследованию роли парейдолии в рентгенологии и её возможностей в повышении эффективности диагностики и обучения специалистов. Парейдолия — явление, при котором человек видит иллюзорные образы в случайных объектах, например лица на поверхности Луны или фигур животных в облаках. В рентгенологии это может проявляться в обнаружении знакомых образов на медицинских изображениях, что помогает врачам выявлять патологии и улучшать навыки в лучевой диагностике.

Целью данной работы было изучение парейдолий, возникающих в процессе интерпретации рентгенологических изображений, а также определение возможных направлений их дальнейшего применения.

Для формирования набора данных с парейдолическими иллюзиями авторы организовали конкурс (с июня по декабрь 2023 г.), в котором приняли участие 31 человек — как специалисты в области медицинской визуализации, так и все желающие, имеющие доступ к рентгенологическим изображениям. Дополнительно вне конкурса собраны изображения ещё от 9 участников. Всего получено 71 изображение. Для сбора данных использовали форму на платформе Яндекс.Формы, где участники загружали свои изображения. Критерии включения и исключения чётко определены для обеспечения качества данных.

Анализ собранных данных показал, что чаще всего люди видят «лица» и «мордочки животных», а также символ «сердца», что открывает перспективы для дальнейших исследований. Обсуждают возможности использования парейдолий в разработке нейронных сетей для автоматического анализа медицинских изображений, а также в образовательной деятельности для стимулирования творческого мышления и ассоциации.

Статья подчёркивает важность продолжения исследований в этой области и расширения базы данных для создания эффективных инструментов диагностики и образовательных программ.

Ключевые слова: парейдолия; искусственный интеллект; образные симптомы в рентгенологии.

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影像学中的视觉意象：空想性错视对医生与人工智能的辅助作用

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摘要

本文探讨了空想性错视（pareidolia）在放射学中的作用及其在提高诊断效率和专业人员培训中的潜力。空想性错视是一种现象，即人们在随机物体中感知到虚幻的图像，例如在月球表面看到人脸，或在云层中辨认出动物形状。在放射学中，这种现象可能表现为在医学影像上识别出熟悉的形象，从而帮助医生发现病变并提升影像诊断技能。

本研究的目的在于探讨放射影像学解读过程中出现的空想性错视现象，并确定其进一步应用的潜在方向。

为建立包含空想性错视影像的数据集，作者举办了一场竞赛（2023年6月至12月），共有31名参与者，包括医学影像学专业人员及其他有权限接触放射学影像的志愿者，提交了影像。另有9名参与者在竞赛之外提供影像。最终共收集71幅影像。数据通过Yandex.Forms平台收集，参与者在该平台上传影像。纳入与排除标准被严格设定，以保证数据质量。

数据分析显示，人们最常见的错视包括“人脸”、“动物面孔”以及“心形”符号，这为后续研究提供了新方向。文章还讨论了空想性错视在神经网络自动化医学影像分析中的潜在应用，以及在教育活动中激发创造性思维和联想的价值。

研究强调了继续开展相关研究的重要性，并指出需进一步扩充数据库，以便开发更高效的诊断工具和教育方案。

关键词：空想性错视；人工智能；放射学中的意象症状。

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INTRODUCTION

Pareidolia is a visual perception phenomenon in which the brain interprets random stimuli (spots, shadows, patterns) as meaningful images. Common everyday examples of pareidolia include perceiving a face on the surface of the Moon or animal shapes in clouds. Notably, pareidolia does not always result in visual illusions and may also occur in other sensory domains (for example, when listening to recorded music played in reverse). Pareidolic phenomena arise from the same neural processes that extract real, rather than imagined, meaning from salient objects in the surrounding world [1].

Imaging findings that resemble objects not actually present in the image are, by analogy with everyday experience, referred to as pareidolic illusions, metaphorical signs, or visual illusions. Such signs have been widely discussed in scientific publications and are frequently used in physician training programs. The use of pareidolic signs in teaching the interpretation of radiologic images increases medical student engagement, descriptive abilities, and short-term retention of material compared with conventional anatomy-based explanations of the same content [2].

Beyond education, pareidolia may also be used to reduce the number of diagnostic errors in radiology. The frequency of such errors is estimated at 4%, corresponding to approximately 40 million errors annually, and this figure has remained remarkably stable over the past 70 years [3, 4]. Computer-based decision support methods are expected to improve diagnostic accuracy; however, at present, these same technologies place new demands on radiologists and may give rise to new sources of perceptual error [5–7].

For this reason, radiologists who are familiar with common perceptual illusions may not only be better able to avoid diagnostic errors but may also use such illusions, when present, to establish a diagnosis [8].

Although pareidolia is often perceived as an incidental finding, in diagnostic imaging it may be representative of specific conditions and therefore clinically useful for establishing a diagnosis [9]. Radiologists have described many such diagnostic signs—visual illusions that indicate the presence of a particular condition or disease [10, 11]. Table 1 [12–22] presents a selection of pareidolic signs that frequently serve as effective diagnostic heuristics [23, 24].

Until recently, these signs were largely empirical; however, artificial intelligence technologies have opened up new opportunities for their analysis. Image analysis tools, including computer vision, have become an integral part of modern life [25]. Healthcare is no exception: one of the largest initiatives in this field is the Experiment on Using

Table 1. Examples of pareidolic signs used as diagnostic heuristics in radiology

Visual illusion	Description	Reference
Snowman sign	• Visualized in the sellar region; • Suggests that a pituitary macroadenoma is more likely than a meningioma.	[12]
Swallow tail sign	• In certain cases, the absence of this pareidolic sign may indicate the presence of disease; • Linear or comma-shaped structures (resembling a swallow's tail) are normally seen in images of the substantia nigra but are absent in most patients with Parkinson disease or dementia with Lewy bodies.	[13]
Wisdom tooth (molar tooth) sign	• On axial computed tomography images, the midbrain resembles a molar or wisdom tooth; • The wisdom tooth sign was first described in Joubert syndrome and related ciliopathies.	[14, 15]
Hummingbird, penguin, Mickey Mouse signs	• On mid-sagittal magnetic resonance imaging, midbrain atrophy in patients with progressive supranuclear palsy resembles a hummingbird or penguin; • On axial images, the atrophic midbrain forms a Mickey Mouse face with paired ears represented by the cerebral peduncles.	[16, 17]
Double panda sign	• Associated with Wilson disease; • Characterized by two distinct panda faces: the giant panda face in the midbrain and the miniature panda face in the pontine tegmentum; • Other conditions, such as methanol intoxication and Leigh disease, may also produce the double panda sign; • Therefore, its presence alone is insufficient for a definitive diagnosis without additional data.	[18]
Eye of the tiger sign	• Neurodegeneration with brain iron accumulation type 1; • Characteristic eye of the tiger appearance in the globus pallidus on T2-weighted magnetic resonance imaging; • Consists of two components: an anteromedial hyperintense focus, likely due to neuronal loss, gliosis, and increased water content, surrounded by a rim of marked hypointensity caused by pathological iron accumulation; • The eye of the tiger sign is considered pathognomonic (present in >95% of cases) for pantothenate kinase–associated neurodegeneration, although it is not entirely specific; • It has also been reported in other brain iron accumulation syndromes and in asymptomatic healthy individuals.	[19–21]
Tadpole sign	• A classic neuroradiological sign of adult-onset Alexander disease; • The late-onset form, caused by mutations in the glial fibrillary acidic protein gene, typically presents with brainstem, cerebellar, or myelopathic symptoms; • The tadpole appearance results from marked atrophy of the medulla oblongata and upper cervical spinal cord; • The spinal cord forms the thin tail, whereas preservation of pontine volume constitutes the head.	[22]

Innovative Computer Vision Technologies for Medical Image Analysis and Their Subsequent Implementation in Healthcare Systems [26, 27]. The digitalization of medical data and the emergence of artificial intelligence–based software capable of its analysis may help to systematize knowledge about pareidolia, identify and substantiate new relationships, and define new ways of its application.

Medicine is not the only domain in which such knowledge is applied. For example, De la Torre [28] employed artificial intelligence technologies to search for extraterrestrial intelligence in images of cosmic objects and suggested that the results of this work may be useful not only for space research but also for understanding the nature of artificial intelligence, its functioning, and certain ethical issues. Furthermore, pareidolia is actively used in psychology and psychotherapy [29], education [30], art,[1] and many other fields [31].

Interest in pareidolia has increased so markedly in recent years that specialized neural networks have been developed that not only detect pareidolic patterns but also generate such images.[2,3]

This work aimed to evaluate pareidolia arising during the interpretation of X-ray images and determine its potential applications.

DATA COLLECTION

To obtain a dataset of pareidolic illusions for subsequent analysis and application, we organized a competition—a volunteer-based project open both to specialists working with medical images and to the general public. The competition, conducted from June to December 2023, was announced through various communication channels, including the website of the Scientific and Practical Clinical Center for Diagnostics and Telemedicine Technologies, as well as the Science ID platform (a national identification and communication service platform for early-career researchers). The initiative attracted 31 participants. Subsequently, outside the competition, images were additionally received from 9 participants.

We collected anonymized radiological images obtained using various imaging modalities, including computed tomography, magnetic resonance imaging, radiography, and ultrasound. The images were provided by medical professionals (radiologists) or participants with authorized access to these data in cases where pareidolic phenomena were observed.

Data were collected using Yandex.Forms® (Yandex, Russia), which ensured a convenient and standardized transfer of images (see Fig. 1).

Inclusion criteria:

- Participants over 18 years of age. Participation of minors was permitted only through legal representatives (e.g., parents);
- Image submission via a dedicated form on Yandex. Forms® (Yandex, Russia), with mandatory informed consent for personal data processing;
- Anonymized medical images (containing no patient-identifying information) accompanied by a brief description.

Exclusion criteria:

- Images containing patient-identifying information, not corresponding to the topic of the competition, or violating the legislation of the Russian Federation or principles of humanity and morality;
- Images submitted by participants under the age of 18 or submitted on behalf of minors without the involvement of legal representatives;
- Images with insufficient resolution or poor quality that impeded recognition of pareidolic illusions;
- Images lacking a clear indication of the associated anatomical region or object;
- Images borrowed from open Internet sources.

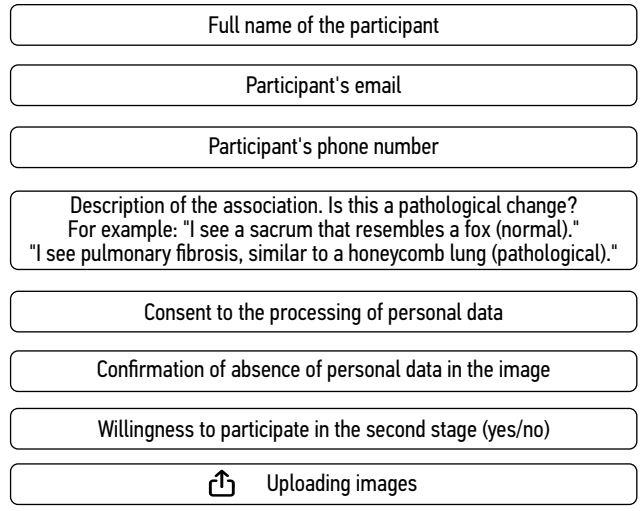

Fig. 1. Form layout. All fields are mandatory. Supported image upload formats include the Joint Photographic Experts Group (JPEG) and the Portable Network Graphics (PNG).

[1] Pareidolia, face detection on grains of sand, installation [Internet]. Den Burg: Driessens & Verstappen; 2019–. Available at: https://notnot.home.xs4all.nl/pareidolia/pareidolia.html. Accessed on: September 15, 2024.

[2] How to create hidden face portraits on MidJourney: Optical illusions: Making double images with AI art. [In Russ.]; [approximately 10 pages] In: Midjourney [Internet]. St. Petersburg: vc.ru, 2023–2024. Available at: https://vc.ru/midjourney/945132-kak-sozdat-zamaskirovannye-v-izobrazheniyah-portrety-opticheskie-illyuzii-v-midjourney. Accessed on: September 15, 2024.

[3] DeepDream Algorithmic Pareidolia Or the Hallucinatory Code of Perception [Internet]. In: The Door of Perception. Berlin: Ben Roth, 2015–2014. Available at: https://doorofperception.com/2015/10/google-deep-dream-inceptionism/. Accessed on: September 15, 2024.

DATA ANALYSIS

Images were selected by members of the competition jury using a 5-point scale:

- Image quality: up to 1 point;
- Originality: up to 2 points;
- Degree of associative similarity: up to 2 points.

Subsequently, the images were categorized into groups according to visual features.

ETHICAL CONSIDERATIONS

No approval from an ethics committee was obtained within this project. All participants were informed about the purpose of the project and participated voluntarily. Participants were free to leave the project at any time.

RESULTS

As a result of the competition, a dataset comprising 71 images containing pareidolic illusions was collected. A detailed breakdown of the dataset is presented in Table 2.

Examples of the most illustrative and noteworthy images are shown in Figures 2–10.

Analysis of the collected images revealed a predominance of face-like pareidolic patterns, which is consistent with a social perceptual mechanism acquired by humans during evolution [32]. The second most frequent category included animal faces (e.g., resembling rabbits, dogs, raccoons, hyenas, squids, etc.). Moreover, a considerable number of images resembling a "heart" were identified (not as an anatomical structure on medical images, but as a symbolic representation). This warrants further investigation, as no scientific publications explaining this phenomenon were identified. Animal silhouettes (e.g., penguins, hedgehogs, dogs, swans) were also frequently observed on medical images.

Most pareidolic patterns were represented by single instances, which precludes in-depth analysis of interrelationships in their current form and necessitates further identification of similar pathologies and anatomical localizations. Nevertheless, the obtained results may be applied for several purposes. First, they may serve as a basis for the development of neural networks for radiological image analysis aimed at automating the detection of similar patterns.

The identified images should be annotated for the presence of pareidolia and organized into datasets according to the described methodology [33], including the anonymization process.[4] Such datasets can then be analyzed to identify associations between pareidolic patterns and pathological features or anatomical characteristics.

Table 2. Visual features identified in pareidolic images

Visual feature	Number of images, *n*	Imaging modality
Face	15	Computed tomography
Animal face	10	Computed tomography
Heart	11	Computed tomography, ultrasound
Swan	4	Computed tomography
Virus	3	Computed tomography
Ink blot	2	Computed tomography
Star	2	Magnetic resonance imaging
Mandarin orange	2	Computed tomography
Eye	1	Computed tomography
Layered cake	1	Computed tomography
Mercedes sign	1	Computed tomography
Pomegranate seeds	1	Computed tomography
Ghost	1	Computed tomography
Sunset	1	Computed tomography
Eyelashes	1	Computed tomography
Avocado	1	Magnetic resonance imaging
Bat	1	Computed tomography
Mushroom	1	Computed tomography
Footprint	1	Magnetic resonance imaging
Penguin	1	Computed tomography
Question mark	1	Computed tomography
Sun	1	Computed tomography
Fire	1	Computed tomography
Explosion	1	Computed tomography
Hedgehog	1	Computed tomography
Clock (infinity) sign	1	Magnetic resonance imaging
Dogs	1	Computed tomography (reconstruction)
Maple leaf	1	Computed tomography
Spider legs	1	Computed tomography (reconstruction)
Ink in water	1	Magnetic resonance imaging

Ultimately, this approach may facilitate the systematization of such visual signs and enable their use in medical education and in improving diagnostic accuracy [2, 34, 35].

Moreover, this work may be further extended from psychological, educational, and even psychiatric perspectives by using the collected images to explore associations between various visual features, states, and personality characteristics. Such associations have already been identified in several domains. For example,

[4] Certificate of state registration of computer software No. 2024680469 of August 29, 2024. Bull. No. 9. Vadilyev Yu.A., Arzamasov K. M., Omelyanskaya O.V. et al. A Software Module to Upload, Select, and De-identify Studies in DICOM Format Stored in the Unified Radiological Information System of Moscow. Available at: https://www.elibrary.ru/download/elibrary_69596606_86670510.PDF. Accessed on: September 15, 2024.

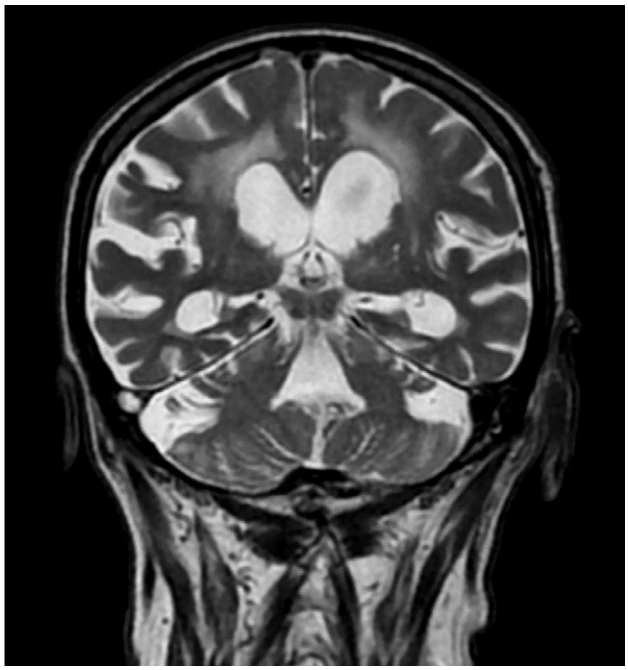

Fig. 2. Magnetic resonance image of the cerebral ventricular system, T2-weighted image, coronal plane: ventricular dilatation is noted (visually resembling a bunny asking for a hug). From the archive of L.R. Abuladze. Published for the first time with permission of the copyright holder.

Fig. 3. Abdominal computed tomography, axial plane: an inferior vena cava filter is visualized (visually resembling a maple leaf). From the archive of V.A. Gombolevskiy. Published for the first time with permission of the copyright holder.

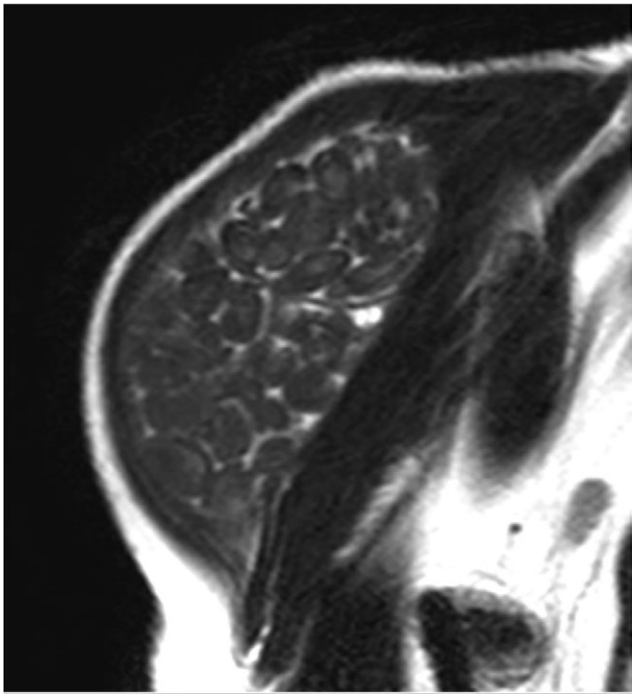

Fig. 4. Magnetic resonance image of the shoulder joint, T2-weighted image: massive immature synovial chondromatosis (visually resembling pomegranate seeds). From the archive of A.Yu. Popov. Published for the first time with permission of the copyright holder.

Fig. 5. Computed tomography of the brain, frontal plane: narrowing of the convexital sulci, dilatation of the lateral and third ventricles (on the visible image), and blurring of gray–white matter differentiation, consistent with cerebral edema and internal hydrocephalus (visually resembling the face of a raccoon [panda]). From the archive of V.S. Somov. Published for the first time with permission of the copyright holder.

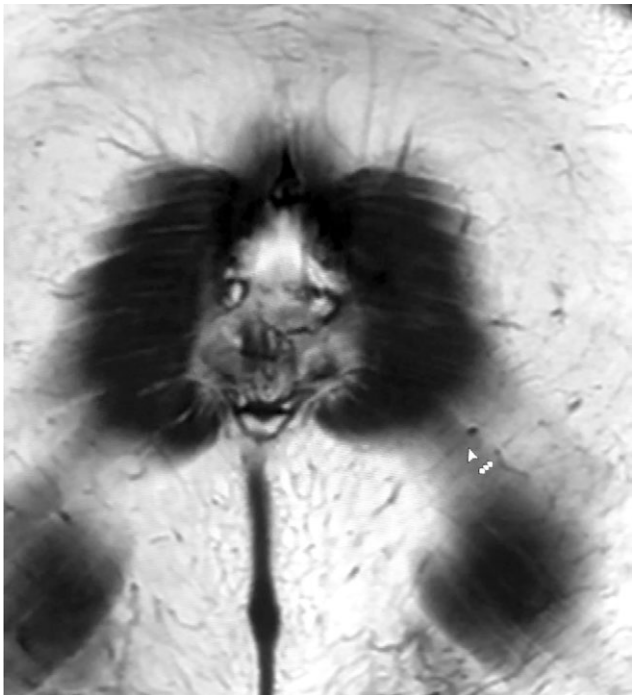

Fig. 6. Magnetic resonance image of the sacrum, T2-weighted image: normal findings (visually resembling a hyena). From the archive of Yu.A. Tsybulskaya. Published for the first time with permission of the copyright holder.

Fig. 7. Magnetic resonance image of the pelvis, T2-weighted image, sagittal plane: dermoid cyst (visually resembling an avocado). From the archive of D.U. Shikhmuradov. Published for the first time with permission of the copyright holder.

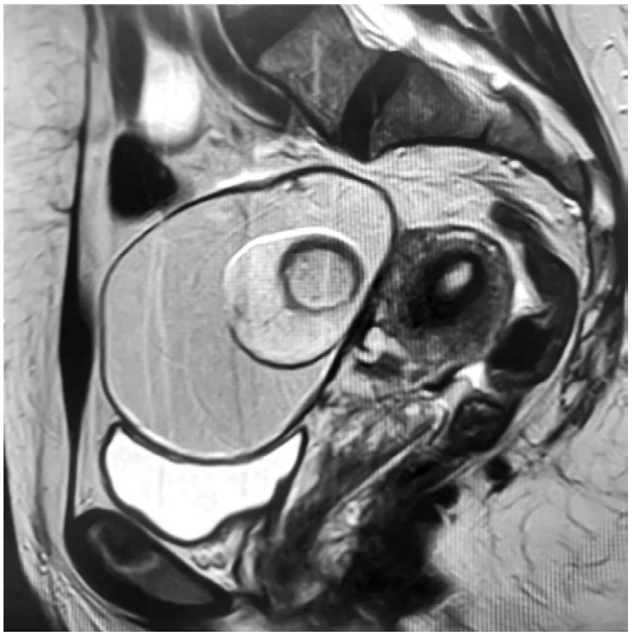

Fig. 8. Magnetic resonance image of the pelvis, T1-weighted image, axial plane: congenital anomaly of the male urogenital system—seminal vesicle cyst (visually resembling a human footprint). From the archive of P.A. Chastoyedov. Published for the first time with permission of the copyright holder.

Fig. 9. Computed tomography of the maxilla, axial plane: dental cusps and interdental fossae of molars (visually resembling smiley faces). From the archive of O.A. Yaroslavtseva. Published for the first time with permission of the copyright holder.

Fig. 10. Computed tomography of the head, coronal plane: hydrocephalus (visually resembling a heart). From the archive of E.A. Slavushcheva. Published for the first time with permission of the copyright holder.

pareidolia is used in psychological testing, most notably in the Rorschach inkblot test for personality assessment, which allows detecting certain mental disorders. Pareidolia may induce altered states of consciousness, accompany various forms of delirium, contribute to the diagnosis of Alzheimer disease [36–39], and may even be a marker of schizophrenia [40, 41]. Furthermore, associations have been reported between face recognition ability and prematurity in children [42]. Pareidolia, as an element of associative thinking, can also be applied in education, for instance, to promote psychological openness, facilitate the development of verbal and emotional skills [43], foster creative thinking [30, 44], and be utilized in art therapy [29].

Finally, this phenomenon is studied in fields far removed from medicine and pedagogy. For example, relationships have been explored between the ability to perceive pareidolia and levels of creativity [45], as well as the role of optical illusions in design [46] and architecture [47]. Pareidolia has also been discussed in the context of interpreting ancient rock art [48]. The monograph Thoracoabdominal Computed Tomography: Images and Symptoms by Yudin [49] describes numerous illusory signs identified during computed tomography image analysis. The author highlights pareidolia as metaphorical symptoms and provides illustrative examples demonstrating the challenges of visual data interpretation in diagnostic practice. Nevertheless, scientific publications on pareidolia remain scarce (searches for the term *pareidolia* yielded 57, 28, and 124 publications in eLibrary, CyberLeninka, and PubMed, respectively). At the same time, pareidolia is more frequently mentioned in popular science sources, where it attracts broad public interest, evokes emotional responses, and stimulates the desire to document and share such observations. For this reason, the present project was conceived to enable not only a comprehensive scientific investigation in radiology but also the extrapolation of its findings to other fields and their dissemination to a wider audience, thereby fostering interest in science.

CONCLUSION

As part of the further development of the project, several key steps are envisaged. Based on the collected images, artificial intelligence models will be trained to identify and analyze the underlying mechanisms and associations between pareidolia and diagnostic as well as educational processes. The resulting data may contribute to improving the training of radiologists (when integrated into educational programs), as well as to enhancing the performance of artificial intelligence–based models in recognizing pathological features on medical images, thereby increasing diagnostic accuracy and efficiency in clinical practice.

We also plan to continue collecting images containing pareidolic patterns to expand the dataset used both for artificial intelligence training and for scientific research. This will enable the identification of new aspects of pareidolia application in medicine and education.

In addition, we intend to develop educational programs for medical students and clinicians that incorporate pareidolia-based examples to improve visual perception and diagnostic skills. These programs may also be adapted for use in general education settings, contributing to the development of creative and associative thinking in children.

Special emphasis will be placed on encouraging young people to pursue a career in radiology and promoting medicine and science through educational activities, such as visits to medical institutions and workshops conducted by practicing specialists.

Notably, at the current stage, the number of collected images is insufficient to fully implement all planned objectives, which is related to a limited audience reach and low participant motivation. Therefore, we plan to scale the project to a broader audience. Furthermore, through the phenomenon of pareidolia, the project aims to promote scientific interest among young people, including awareness of modern data analysis methods and the development of artificial intelligence models.

ADDITIONAL INFORMATION

Author contributions: A.V. Solovev, T.M. Bobrovskaya, M.A. Zelenova: conceptualization, methodology, writing—original draft, writing—review & editing; O.V. Omelyanskaya: conceptualization, writing—review & editing, supervision. All the authors approved the version of the manuscript to be published and agreed to be accountable for all aspects of the work, ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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