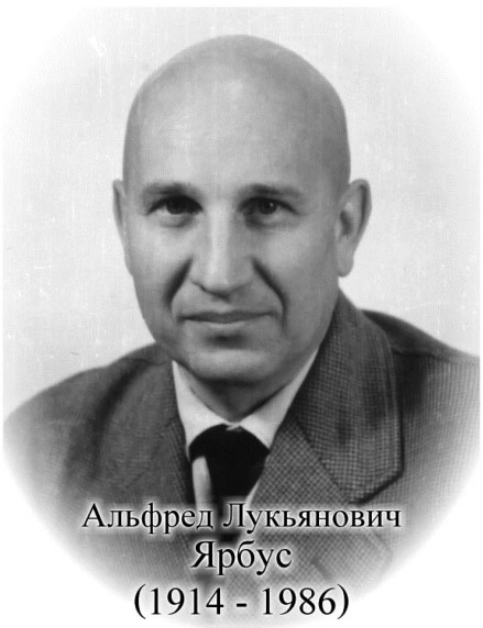
Guest Editorial

PERCEPTION

Perception
2015, Vol. 44(8–9) 837–850

DOI: 10.1177/0301006615595782
pec.sagepub.com
SAGE

Scientific Activity of Alfred Yarbus: The Stages of Research Work, Senior and Younger Colleagues, Conditions of Investigations



1941: graduated from the Moscow State University (Faculty of Physics)
1941–1942: factory engineer (Moscow)
1942–1946: Military service (Karelia, then Far East Japanese front)
1946–1947: researcher at the Institute of Crystallography
1947–1950: doctoral student at the Psychology Department of the Institute of Philosophy, (Academy of Sciences of the USSR), supervisor—S. V. Kravkov
1950–1963: researcher, senior scientist (since 1957) at the Institute of Biophysics (Academy of Sciences of the USSR), the Laboratory for biophysics of vision
1963–1986: senior scientist at the Institute for Information Transmission Problems (Academy of Sciences of the USSR)

Early Stage of Research Career

Alfred Lukyanovich Yarbus started a research work in visual perception in 1947, soon after the end of his military service in Far East. He completed his first significant investigation at the Psychology Department of the Institute of Philosophy (Academy of Sciences of the USSR) under the supervision of Professor Sergei Vasil'yevich Kravkov (1893–1951) who worked there

since 1945. At that time, S. V. Kravkov was also a head of research groups on sensory physiology at the Moscow Helmholtz Research Institute of Eye Diseases (1936–1951) and at the Institute of Psychology (Academy of Pedagogical Sciences of the USSR, 1931–1951).

Sergei V. Kravkov was an outstanding psychologist and physiologist, the author of a fundamental monograph *Eye and Its Work* (1950, in Russian) and of a treatise on color vision (1951), which was translated into German. He published numerous articles on visual adaptation and the impact of nonvisual factors (sounds, odors, drugs, electric current, starvation, hyperventilation, etc.) on visual acuity. During the World War, Kravkov and his collaborators studied the effects that exposure to searchlight and snowblink produced on soldiers' vision.

S. V. Kravkov

The PhD dissertation of Yarbus was devoted to geometrical illusions; results of this research were published during the period from 1948 to 1952. Investigating visual perception of sizes and distances in the presence of adjacent confusing elements (e.g., Müller-Lyer and Ebbinghaus configurations, diagonals in the parallelogram, equal segments imposed on the perspective lines, etc.), and overestimation of the upper part of the figures (such as B and 8), Yarbus concluded that cognitive factors and form or size constancy mechanisms made significant contribution to the development of geometrical illusions.

A. R. Luria

It is likely that Yarbus's investigation of geometrical illusions was stimulated by some earlier studies carried out by Alexander Romanovich Luria (1902–1977) who was one of the leaders of the Russian psychology at that time. At present, Luria is internationally known as a founder of a new branch of psychological science—neuropsychology—and the author of many books translated into several languages. However, the history of his investigations concerning visual illusions is somewhat dramatic.

In the 1930s, trying to clarify the role of visual experience in the development of some geometrical illusions, Luria undertook several expeditions to remote villages in Uzbekistan (Central Asia). His intention was to explore mental processes

of people from different cultural backgrounds. The findings were highly praised by Lev Semyonovich Vygotsky (1896–1932), Luria's professor and mentor, but they got cool reception from science policy officials. Luria was heavily criticized for his remark that "Uzbek people do not have illusions." The anecdote goes that the officials suspected antiSoviet content in this phrase despite the fact that Luria simply emphasized the peculiarities of optical illusions in barely literate people. His Central Asian research was suspended and ignored for many years. Luria only managed to summarize these findings in 1974 in his book *The Historical Development of Cognitive Processes*.

Direct cooperation between Yarbus and Luria took place later, in 1960s. Their joint research concerned impairment of visual perception and eye movements in patients with neuropathology. Luria and his colleagues published five papers in coauthorship with Yarbus—more than Yarbus's colleagues from the laboratory during the whole period of his work.

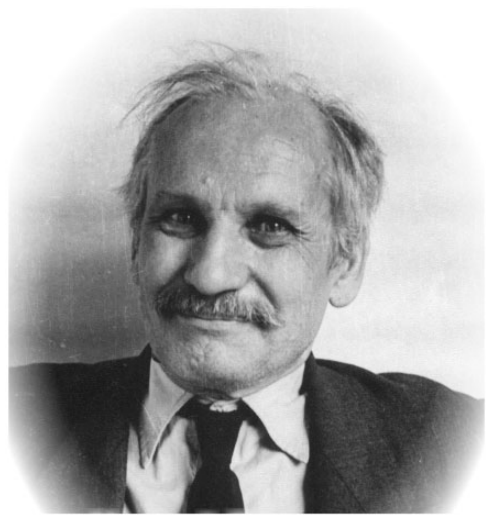
After Kravkov's death in 1951, Yarbus continued his investigations at the Institute of Biological Physics (Academy of Sciences of the USSR) in the Laboratory for Biophysics of Vision. At that time, the laboratory was headed by G. K. Gurtovoy (1915–2004) but he left it soon after. Nikolay Dmitrievich Nyberg (1899–1967), who became the next head of the laboratory, was just the right person needed at that position; the period of his guidance was the Golden Age of investigations in the laboratory.

The Golden Age

Nikolay D. Nyberg directed the laboratory from 1954 until his death in 1967. He was a man of great erudition, a school friend of the famous Russian mathematician A. N. Kolmogorov.

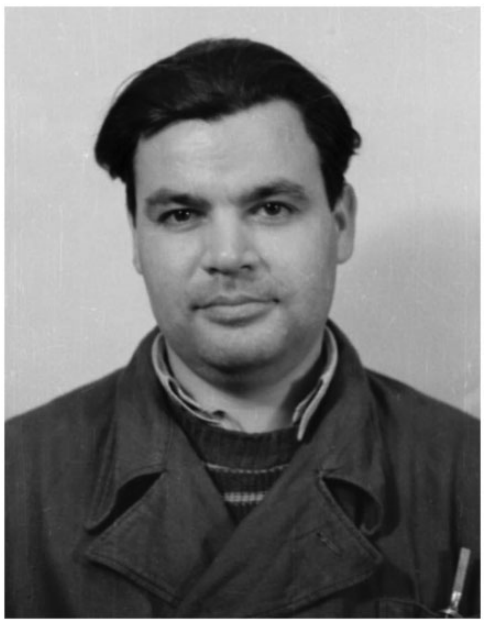
Being a specialist in color perception, Nyberg appreciated all theoretical and practical problems much more profoundly than his younger colleagues. Due to this distance, it was often difficult for Nyberg to discuss something on an equal footing with his opponents. Sometimes, he lost his temper and used his walking stick as an additional argument. However, nobody was offended because Nyberg had unquestionable authority and was a very fascinating, keen, and kind personality in everyday life.

Nyberg devoted all his life to solving the fundamental problems of color vision and color reproduction. He received international recognition for his investigations of the color solid, a notion introduced by a German scientist R. Luther to describe 3-D human color vision system (1927). Following Luther's publication, Nyberg established geometrical properties of the color solid, defining its shape and borders in color space. He published his findings simultaneously in Russian and in German scientific journals. Nyberg's most significant contribution to the development of color-solid theory now bears his name along with Luther's and is known as *Luther–Nyberg color solid*.



N. D. Nyberg

During Nyberg's leadership, Yarbus carried out his basic research on eye movements and their role in vision. His innovative eye-tracking recording technique was successfully



Vadim Chernyshov

accomplished in the laboratory due to technical support of excellent mechanical engineers Vadim Chernyshov and Vyacheslav Drozdov.

In fact, the original idea to use a suction cap for the purposes of eye movement tracking belonged to Chernyshov, who made the very first rubber device. Later, Yarbus devised the more practical metal caps and proposed many modifications suitable for specific purposes. After Chernyshov had left the laboratory for the Moscow State University, Yarbus continued to implement his ideas mostly in cooperation with Drozdov.

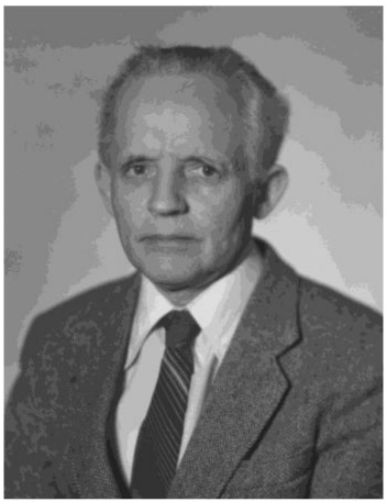
At the beginning of 1950s, there was only a small group of researchers in the laboratory beside Nyberg, Yarbus, two engineers, and two assistants: These were Georgy A. Mazokhin-Porshn'yakov, Lyubov P. Kuznetsova (Galochkina), Iya A. Knorre (Utina), and Oleg Yu. Orlov. Most of them were in the early stage of their research careers.

G. A. Mazokhin-Porshn'yakov

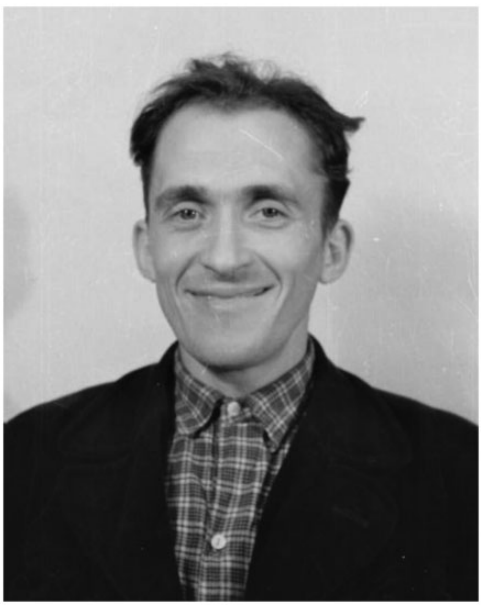
The entomologist Georgy Mazokhin-Porshn'yakov (1924–1998) appeared to be the most prolific researcher in the group. He published 230 papers on insect visual behavior and constancy of bees' visual perception and wrote an excellent monograph on vision in social insects *Insect Vision* (1965, in Russian), which was translated in the United States in 1969.

In 1957, the laboratory staff increased incorporating a specialist in sensory neurophysiology Alexey L. Byzov, and Konstantin V. Golubtsov—an electronic engineer, designer of many original devices for the neurophysiological research.

In the Soviet Union, Alexey L. Byzov (1926–1998) was one of the leaders in the field of electrophysiology of the vertebrate retina, particularly in intracellular and extracellular recording of the retinal unit responses. The author of numerous articles and a monograph *Electrophysiological Study of the Retina* (1966), Byzov also served on the Editorial Board of the *Vision Research* for many years.



A. L. Byzov



K. V. Golubtsov

Konstantin V. Golubtsov (1929–2014), the talented engineer and biologist, invented and produced a lot of various devices not only for his colleagues in the laboratory but also for the colleagues from many other institutions in Moscow, Leningrad (Saint-Petersburg), Kazan, Irkutsk, Vladivostok, and so forth. His amplifiers for neurophysiological studies were employed all over the country; for the projects of Mazokhin-Porshn'yakov, he created original insect light traps and a star photometer; together with Byzov, he produced a device for making fine glass micropipettes that considerably improved registration of electrical activity of neurons.

Nyberg actively promoted mathematical approaches to biological research at the laboratory. He agreed to be the head of the laboratory on condition that the staff would be extended by incorporating more researchers with background in physics and mathematics. As a result of this, Mikhail Bongard, the first researcher of artificial intelligence in Russia, and Mikhail Smirnov, now acknowledged as a founder of adaptive optics, were hired to Nyberg's laboratory. Their careers started far from the academia world. It's funny that, after their graduation from Moscow State University, these two young physicists were assigned: one to a lamp plant and the other to a musical instrument factory that produced Russian folk three-strings balalaikas. However, management of the factories could not put their new employees to good use, and they quit. In the laboratory, Bongard and Smirnov usually worked together on the ''hottest'' points of current research, although each of them had his own area of special interest.

Mikhail Moiseevich Bongard (1924–1971) developed into a brilliant specialist in pattern recognition and computer modeling of mental activities. He promoted fundamental advances in the field of machine learning methods and color perception. His monograph *Pattern Recognition* (1967, in Russian) was translated into English and published in the United States in 1970. He received international recognition for the *Bongard problems*—a set of problems to test intelligence of machines.

M. M. Bongard

M. S. Smirnov

Mikhail Sergeevich Smirnov (1921–2008) was mostly interested in ocular optics. His PhD study was carried out at the Moscow Helmholtz Research Institute of Eye Diseases and was based on a thorough investigation of individual eye aberrations. He created his own original method for precisely measuring the components of aberrations at dozens of points uniformly distributed over the pupil area and calculated the characteristics of the contact lens compensating these aberrations to obtain the eye with ideal optical properties. The paper summarizing these results was published in 1961 and, much later, constituted the basis of the modern adaptive optics. His less traditional scientific interests were related to the field of extrasensory perception in humans. Along with unaided transmission of thoughts and other paranormal capabilities, he studied the phenomenon of Roza Kuleshova, who could identify letters and colors with fingers of her hand when blindfolded. It is noteworthy that this investigation was performed in cooperation with his friend Mikhail Bongard who could not resist the temptation of studying this unusual phenomenon.

During the 1960s, Yarbus enjoyed very productive period of his academic career marked by several great accomplishments. In 1964, he received his second PhD in biology for invention of the method of micro suction caps for eye movement recording. In 1965, he published his landmark book *The Role of Eye Movements in Vision* (Moscow: Nauka) which appeared in English translation in 1967 as *Eye Movements and Vision*.

At that period, more graduates from Moscow State University (Elena M. Maksimova (Lazareva), Yury A. Trifonov, Tamara M. Vishnevskaya, Petr P. Nikolaev) and from Moscow Institute of Physics and Technology (Vadim V. Maksimov, Gary M. Zenkin,

Alexander P. Petrov) joined the laboratory. Also, Modest N. Weinzweig left the Institute of Biophysics to become another member of the laboratory. Inspired by Nyberg's and Bongard's ideas, Vadim Maximov and Modest Weinzweig appeared to be involved in developing theories of pattern recognition and color perception. Twenty years later, Maximov published a book *Transformation of Colour Under Change of Illumination* (1984, in Russian). Alexander Petrov (1939–1997) and Gary Zenkin tried to develop a general concept of spatial constancy on the basis of their experiments with afterimages observed in conditions of eye and head movements.

Jury Trifonov

Yury A. Trifonov (1937–1986) was initially a doctoral student of Byzov. He studied electrical activity accompanying signal processing in the retina of vertebrates. He was the first in the world to discover that, unlike other cells, the retinal horizontal cells were depolarized in darkness and hyperpolarized when illuminated.

The Last Period of Research

After publishing his book on the role of eye movements, Yarbus was going to write a second book summarizing his data on color perception (which remained beyond the scope of his first book) and to present his own original theory of color vision and, perhaps, more than that—a general theory of vision. Evidently, this task appeared to be more difficult than it seemed initially–there was a pause of about 10 years between completing the manuscript of the first book in 1964 and publishing the first paper from the series (1975–1980) related to the second one (not realized). During this time, Yarbus only rarely performed the experiments having direct relation to the content of the planned book. Meanwhile, Yarbus's ideas came into great prominence in Russia.

At the end of the 1960s and beginning of 1970s, the staff of the laboratory increased mostly due to the researchers intending to simulate (on mathematical and electronic models) the phenomena described by Yarbus and to develop his ideas. Ilya S. Losev and Tatiana A. Shura-Bura tried to create a mathematical model of visual system employing Yarbus' ideas. Petr P. Nikolaev, Vladimir E. Shchadrin, Galina I. Rozhkova, and Abram M. Dimentman carried out a series of comparative investigations with various stabilized retinal images observed under monocular and binocular viewing conditions.

During the last period of his research career, Yarbus was mainly interested in finishing his new monograph on color perception. He published a series of 10 papers on color perception in *Biophysics* (1975–1980) but this project remained uncompleted.

Conditions of Work

Until 1962, the laboratory was located in the Vyshinsky Institute of State and Law in Moscow downtown at 10, Frunze St. In 1963, because of a radical reorganization of

Moscow scientific institutions, aimed at the creation of several new research institutes outside Moscow, the laboratory was transferred to the newly founded Institute for Information Transmission Problems, directed by Alexander A. Kharkevich.

Alexander A. Kharkevich (1904–1965) was a prominent specialist in information transmission and the author of numerous papers in telecommunications. His monograph *Essays on General Theory of Communications* (1955) was the first fundamental work on information theory in Russia.

A. A. Kharkevich

The Institute incorporated several very diverse laboratories that were scattered throughout the city of Moscow. A global idea of the Institute was to study information transmission and processing everywhere: in broadcasting and telecommunication, in genetics, in contacts between the cells, in sensory information pathways, and so forth. However, the embodiment of this idea resulted in too many different components.

At first, Kharkevich was horrified with such diversity but, gradually, realized the advantages of borrowing and combining approaches from quite different disciplines.

The name of the laboratory was changed from ''Biophysics of Vision'' to ''Information Transmission in Sensory Systems,'' and it was relocated to a basement in a Moscow suburb (22, Bolshaya Ochakovskaya St.). This basement was large enough (300 m^2) but neither very comfortable nor suitable for work: regular sewage floods due to bad drainage, poor ventilation, mold, wood-attacking fungus destroying the floor accompanied scientific investigations as unpleasant ''satellites''. However, the laboratory members paid little attention to these imperfections and, after each cataclysm, re-established acceptable order all together.

The following humorous adaptation of Repin's ''Bargemen on Volga'' symbolizes the hard work of Yarbus and his collaborators. From left to right, among the bargemen, one could recognize Bongard, Nyberg, Mazokhin-Porshn'yakov, Yarbus, Smirnov, Byzov, Chernyshov, Drozdov, Orlov, Golubtsov. The name written on of the barge is ''Biophysics of Vision.''

In the basement, Yarbus had a separate study, one of the best rooms regarding the condition of its floor and walls. He usually did not let anyone attend his experiments except the subject participating in a current session. Most subjects were his colleagues and among his favorites was Nina Polischuk who was very brave and was not afraid of discomfort in her eyes.

The largest room of the laboratory was used for lunches, playing table tennis, holding seminars, and celebrations that occurred regularly, the merriest celebration being for the New Year. On such occasions, Yarbus liked to prepare various herb tipples and, for the New Year party, Yarbus and Zenkin usually produced a handmade wall newspaper with humorous description of the lab events and jokes.

Coauthors

Yarbus carried out only a small part of his research in collaboration with colleagues from the laboratory or other institutions. Most of those joint investigations were of applied character and differed from his main research interests.

In 1955, Yarbus and Naum I. Goltsman recorded convergent–divergent eye movements in subjects viewing a stereoscopic film and tracking virtual images moving in depth. Those experiments were performed at the Scientific Research Institute of Cinematography. For stereo movie demonstration, Yarbus and Goltsman used unique lens-raster screens that allowed viewing stereo images without stereo glasses—a technique which, at that time, was available only in Moscow. Apparently, this study was the first ever of its kind.

During 1961 to 1965, Yarbus participated in the studies of eye movements in patients with neuropathology undertaken by Alexander Luria and his colleagues. The results of these studies were published in several papers both in Russian and in English.

In the 1970s, Yarbus conducted some experimental studies in collaboration with Galina I. Rozhkova. These investigations were devoted to the peculiarities of central and peripheral visual mechanisms, and the most interesting findings were obtained using miniature opaque circles and rings fixed on the suction cap to exclude certain retinal areas from visual stimulation.

The only doctoral student of Yarbus was Nadezhda S. Surovicheva, whose dissertation concerned pursuit eye movements. However, this dissertation was completed after his death under the supervision of Dmitry G. Lebedev.

Access to Foreign Literature

Unfortunately, during the time of Yarbus's research work, access to foreign literature was very scarce and limited. In Moscow, most scientific books and journals were only available in the three largest libraries, and reader had often to stand in line for 2 to 3 hours to enter the library. Access to the most part of psychological literature from the nonSoviet countries was officially restricted due to the preconceived opinion that the ''bourgeois'' psychology was allegedly ''alien'' to Soviet people. One couldn't consult *Perception* even at the Lenin State Library, the largest in the country and in Europe. The situation with biological literature was

somewhat better and, moreover, since 1975, the laboratory had a full set of *Vision Research* at the basement because Alexey Byzov was on the editorial board of this journal.

An additional difficulty for Yarbus was the fact that he didn't study English and had to ask somebody to help him with translation when it was necessary to read English papers. Of course, he knew Polish perfectly, but the relevant Polish literature was sparse. In addition, Yarbus could read German scientific literature but, in Russian libraries, it was much less comprehensive than English language literature.

Contacts With Foreign Colleagues

There were no members of the Communist Party in the laboratory and, therefore, the probability of contacts with foreign colleagues was negligible. Yarbus couldn't accept invitations received from abroad since it was certain that he wouldn't be allowed to go there. In fact, many of such invitations wouldn't even reach him—they remained undelivered. It was only the rare visitors from abroad with whom Yarbus could discuss his findings and problems.

Yarbu's Legacy

In total, Yarbus published one monograph translated into English and 44 papers. All papers were submitted to Russian journals to avoid difficulties with translation, and also the humiliating procedures that were obligatory in the USSR for sending papers abroad. In particular, the author would have to get a certificate, signed by several experts, that the paper prepared for publication abroad contained no information that could require protection: Essentially, this meant that there was nothing new and important in the manuscript!

Most papers of Yarbus were quite short since, in Russian journals, the permissible article size was limited to several pages. After the first series of papers on visual illusions, published during preparation of his PhD dissertation, all the subsequent papers concerned eye movements and their role in vision. Summarizing Yarbus's achievements in this area, one should underscore the following ones:

– elaboration of very precise methods for recording eye movements;
– promotion of an integrative approach to the role of eye movement in vision;
– demonstration of the possibility to use eye movement patterns for studying cognitive processes;
– verification of diagnostic significance of the eye movement disturbances.

In brief, Yarbus's works provided opening a new era in the study of active vision.

Although Yarbus's technique of eye movement recording was not widely adopted because of its complexity and uncomfortable character for the subject, his remarkable findings stimulated further improvement of eye movement recording methods and led to elaboration of modern fine remote contact-free eye-tracking devices. Using his original approach, Yarbus investigated a broad spectrum of issues concerning visual perception and his laconic and iconic style of presenting various findings and concepts constituted the basis of his great popularity.

Galina I. Rozhkova and Andrei N. Sobolevski
Institute for Information Transmission Problems (Kharkevich Institute), Moscow, Russia

Publications by Alfred Yarbus

Monograph

Yarbus, A.L. (1967). Eye movements and vision. New York: Plenum Press.
Translated from Russian by *Basil Haigh*. Translation Editor *Lorrin A. Riggs*.
Ярбус А.Л. Роль движений глаз в процессе зрения. М.: Наука, 1965. 166 с.
(Yarbus, A.L. (1965). The role of eye movements in vision. Moscow: Nauka.)

Papers

1948: **On some illusions in assessment of visible distances between the object edges**.
О некоторых иллюзиях в оценке видимых расстояний между краями предметов / *Исследования по психологии восприятия*. Институт философии. Сектор психологии. М.-Л.: Изд-во АН СССР, 1948. С. 289–303.
1950: **On some illusions in estimating visible sizes of the line segments and their sum**.
О некоторых иллюзиях в оценке видимых частей и сумм отрезков расстояний. *Проблемы физиологической оптики*. 1950. Т. 9. С. 179–190.
1952: **Overestimation of the upper part of the figure**.
Переоценка верхней части фигуры. *Проблемы физиологической оптики*. 1952. Т.10. С. 134–140.
1954: **Investigation of the eye movements accompanying process of vision**.
Исследование закономерностей движений глаз в процессе зрения. *Доклады АН СССР*. 1954. Т. 96. № 4. С. 33–35.
1955: **Eye movements in the process of changing points of fixation**.
Движения глаз в процессе смены точек фиксации. *Труды Института биологической физики*. 1955. Т.1. С. 162–165.
1955: **Eye movements in achromats**.
Движения глаз ахроматов. *Труды Института биологической физики*. 1955. Т.1. № 5. С. 166–171.
1956: **Perception of stabilized retinal image**.
Восприятие неподвижного сетчаточного изображения. *Биофизика*. 1956. Т.1. № 5. С. 435–437.
1956: **On the problem of visual estimation of distances**.
К вопросу о зрительной оценке расстояний. *Сборник, посвященный памяти акад. Лазарева*. 1956. С. 341–343.
1956: **Eye movement recording in the process of reading and viewing images on the plane**.
Запись движений глаз в процессе чтения и рассматривания изображений на плоскости. *Сборник, посвященный памяти акад. Лазарева*. 1956. С. 344–348.
1956: **Plethysmography of the eye ball**.
Плетизмография глазного яблока. *Биофизика*. 1956. Т.1. № 3. С. 242–244.
1956: **Eye movement in the process of changing the fixation points**.
Движение глаз в процессе смены точек фиксации. *Биофизика*. 1956. Т. 1. № 1. С. 76–78
1956: **Velocity of the movement on the retina of the stationary point image in the process of fixation**.
Скорость движения изображения неподвижной точки на сетчатке в процессе фиксации. *Биофизика*. 1956. Т. 1. № 6. С. 593–596.
1956: **A new technique for the eye movement recording**.

Новая методика записи движений глаз. *Биофизика*. 1956. Т.1. С. 713–720.

1957: **New methods for investigating various parts of the retina**.

Новая методика исследования работы различных участков сетчатки глаза. *Биофизика*. 1957. Т. 2. № 2. С. 163–165.

1957: **Eye movements during changes of the stationary points of fixation in space**.

Движения глаз при смене неподвижных точек фиксации в пространстве. *Биофизика*. 1957. Т. 2. № 6. С. 698–702.

1957: **On the problem of the perception of an image fixed in relation to the retina**.

К вопросу о восприятии изображения, неподвижного относительно сетчатки. *Биофизика*. 1957. Т. 2. № 6. С. 703–712.

1959: **On the perception of images moving on the retina with a given velocity**.

О восприятии изображений, перемещающихся по сетчатке с заданной скоростью. *Биофизика*. 1959. Т. 4. № 3. С. 320–328.

1959: **On the role of eye movement in visual process**.

К вопросу о роли движения глаз в процессе зрения. *Биофизика* 1959. Т. 4. № 6. С. 757–758. (Письма в редакцию)

1960: **On the perception of stabilized retinal images with changing brightness**.

О восприятии изображений переменной яркости, неподвижных относительно сетчатки. *Биофизика*. 1960. Т. 5. № 2. С. 159–161.

1960: **On the perception of images of great brightness motionless in respect to the retina**.

О восприятии изображений большой яркости, неподвижных относительно сетчатки глаза. *Биофизика*. 1960. Т. 5. № 3. С. 293–294.

1961: **Eye movements in the course of viewing complex objects**.

Движения глаз при рассматривании сложных объектов. *Биофизика* 1961. Т. 6. № 2. С. 207–212.

1962: **Eye movements during perception of moving objects**.

Движения глаз при восприятии движущихся объектов. *Биофизика*. 1962. Т. 7. № 1. С. 64–69.

1962: **On some experiments with stabilized retinal image**.

О некоторых опытах с изображением, неподвижным относительно сетчатки. *Биофизика*. 1962. Т. 7. № 2. С. 207–210.

1962: **Perception of stabilized retinal images with changing color**.

Восприятие изображений, неподвижных относительно сетчатки и изменяющихся по цвету. *Биофизика*. 1962. Т. 7. № 3. С. 333–335.

1962: **On perception of flickering images stabilized on the eye retina**.

О восприятии мелькающих изображений, неподвижных относительно сетчатки глаза. *Биофизика*. 1962. Т. 7. № 5. С. 615–618.

1975: **Human visual system. I. Adequate visual stimulus**.

О работе зрительной системы человека. I. Адекватный зрительный стимул. *Биофизика*. 1975. Т. 20. № 5. С. 916–919.

1975: **Human visual system. II. The perceived colour**.

О работе зрительной системы человека. II. Цвет. *Биофизика*. 1975. Т. 20. № 6. С. 1099–1104.

1976: **Human visual system. III. The space of colour sensations**.

О работе зрительной системы человека. III. Пространство цветовых ощущений. *Биофизика*. 1976. Т. 21. № 1. С. 150–152.

1976: **Human visual system. IV. Opposite color difference and anticolor. The first series of experiments**.

О работе зрительной системы человека. IV. Обратное цветовое различие и антицвет. *Биофизика*. 1976. Т. 21. № 4. С. 735–738.

1976: **Human visual system. V. Opposite color difference and anticolor. The second series of experiments**.

О работе зрительной системы человека. V. Обратное цветовое различие и антицвет. *Биофизика*. 1976. Т. 21. № 5. С. 913–916.

1977: **Human visual system. VI. Opposite color difference and anticolor. The third series of experiments**.

О работе зрительной системы человека. VI. Обратное цветовое различие и антицвет. *Биофизика*. 1977. Т. 22. № 1. С. 123–126.

1977: **Human visual system. VII. Opposite colour difference and anticolour. Fourth series of experiments**.

О работе зрительной системы человека. VII. Обратное цветовое различие и антицвет. *Биофизика*. 1977. Т. 22. № 1. С.123–126.

1977: **Human visual system. VIII. Description of colour transformations by means of vector algebra**.

О работе зрительной системы человека. VIII. Описание операций с цветами средствами векторной алгебры. *Биофизика*. 1977. Т. 22. № 6. С. 1087–1094.

1979: **On the work of human visual system. Simultaneous and successive contrast**.

О работе зрительной системы человека. Одновременный и последовательный контраст. *Биофизика*. 1979. Т. 24. № 3. С. 524–527.

1980: **Human visual system. Combined role of the retinal image drift and fast changes of retinal sensitivity in perception of colour**.

О работе зрительной системы человека. Роль дрейфа сетчаточного изображения и быстрого изменения чувствительности сетчатки в восприятии цвета. *Биофизика*. 1980. Т. 25. № 3. С. 548–554.

Papers Written With Coauthors

1. Yarbus, A. L. & Goltsman, N. I. (1955). **Eye movements during perception of images in stereo movies**.

Ярбус А.Л., Гольцман Н.И. Движения глаз при восприятии изображений в стереокино. *Труды института биологической физики*. 1955. Т.1. С. 172–177.

2. Luria, A. R., Pravdina-Vinarskaya, E. N. & Yarbus, A. L. (1961). **On the mechanisms of eye movement in visual perception and their pathology. Simultanea agnosia and optical ataxia**.

Лурия А.Р., Правдина-Винарская Е.Н., Ярбус А.Л. К вопросу о механизмах движений глаз в процессе зрительного восприятия и их патологии. Симультанная агнозия и оптическая атаксия. *Вопросы психологии*. 1961. № 5. С.159–172.

3. Luria, A. R., Pravdina-Vinarskaya, E. N. & Yarbuss, A. L. (1963). **Disorders of ocular movements in a case of Simultanagnosia**. *Brain*, 86, 219–228.

4. Luria, A. R., Karpov, B. A. & Yarbus, A. L. (1965). **Disturbances of complex visual perception with lesions of the frontal lobes**.

Лурия А.Р., Карпов Б.А., Ярбус А.Л. Нарушение восприятия сложных зрительных объектов при поражении лобной доли мозга. *Вопросы психологии*. 1965. № 3. С. 45–54.

5. Luria, A. R., Karpov, B. A. & Yarbuss, A. L. (1966). **Disturbances of active visual perception with lesions of the frontal lobes**. *Cortex*, 2, 202–212.

6. Karpov, B. A., Popova, L. T., Korchazhinskaya, V. I. & Yarbus, A. L. (1965). **The pathogenesis of the Balint syndrome**.
Карпов Б.А., Попова Л.Т., Корчажинская В.И., Ярбус А.Л. К патогенезу синдрома Балинта. *Вопросы психологии*. 1965. № 3. С. 828–832.
7. Rozhkova, G. I. & Yarbus, A. L. (1974). **The effects of velocity of retinal image movement on peripheral vision**.
Рожкова Г.И., Ярбус А.Л. Зависимость периферического зрения от скорости смещения сетчаточного изображения. *Биофизика*. 1974. Т. 19. № 5. С. 908–912.
8. Rozhkova, G. I. & Yarbus, A. L. (1977). **The peculiarities of perceiving visual objects in conditions of functioning of the limited areas in the retinal centre**.
Рожкова Г.И., Ярбус А.Л. Особенности восприятия человеком объектов в условиях работы ограниченных центральных участков сетчатки. *Физиология человека*. 1977. Т. 3. № 6. С. 1119–1127.
9. Yarbus, A. L. & Rozhkova, G. I. (1977). **The peculiarities of perceiving visual objects at the periphery of the visual field**.
Ярбус А.Л., Рожкова Г.И. Особенности восприятия человеком объектов на периферии поля зрения. Сб. *Сенсорные системы*. Л.: Наука, 1977. С. 64–72.