

Ivane Javakhishvili Tbilisi State University
Maia Robakidze

The Significance of Phenomenal and Retinal factors in Set Fixation

The dissertation has been developed in the Department of Psychology, Ivane Javakhishvili
Tbilisi State University

Academic Advisor: Givi Qiria, Candidate of Psychological Studies

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The formation of perceptual image is a traditional subject in psychological research. The main aspects of this problem are mechanism of conversion of physical stimulation into perceptual information and the contribution of sensory and phenomenal factors of perception in formation of perceptual image. The investigation of perceptual illusion often helps psychologists to solve this problem. Researching these issues psychologists face some difficulties concerning separating sensory effects from phenomenal ones. Our experimental research may be considered as an attempt to solve these difficulties by asking subjects to compare objects under conditions of divergence of sensory and phenomenal information on one hand and under conditions of their coincidence on other. In one series of experiments subjects were presented objects which sensory sizes were unequal and phenomenal sizes (apparent) – equal; the opposite was true - in the second series – sensory sizes of the objects were the same and phenomenal sizes of the objects were unequal; in the third series - both the sensory and phenomenal sizes were unequal. The results show both sensory and phenomenal unequivalence of objects have contrast effects in process of estimating the magnitude of the objects and we attempt to analyze these effects using Uznadze Set Theory approach. In consequence of statistical analysis we obtained following results: the strength of the set illusion formed on sensory unequivalence and set formed on perceptual one (classical type of set) prevailed over the same index of set fixed on the phenomenal unequivalence. We should admit that information received from sensory channel is more important in the process of set formation.

Chapter 1. Introduction

A large number of studies describe the mechanisms for creating perceptive illusions and the problem with reference to their determination in the classical and modern psychology. They also suggest the reasons explaining interest of the psychologists in the topic. The author claims that the researchers are not directly interested in the illusions as such; rather the topic of their interest is the assumption that acquiring more information about the illusions will shed light on the wide range of the issues, where perception provides exact information about the universe.

The first scientist who expressed interest in the sphere of perceptive illusions was the Roman poet and philosopher (99-55 yy. BC). Regardless the long history of the existence, the illusions became the topic of a more serious research only in the XIX century. In 1854 Opel paid attention to

the existence of the geometric-optical illusions, which led to the vivid interest of the physicists as well as psychologists.(S.Tolansky,1967)

It is known some classification of the theories studying illusions. They can be divided into theories which focus on the physiological reasons, especially highlighting the processes occurring in the periphery of the visual systems; and theories attempting to explain illusions in terms of psychological processes. The latter set of theories dates back to the XIX century. In 1866 Hermann von Helmholtz argued that the basis for the formation of the perceptive image is the unity of the primary, in other words sensory and memory, images (G.Kiria, 1998)

The ideas of Helmholtz, which attempted to explain illusion by means of psychological rather than physiological reasons, are connected with the modern psychological theory titled as Constructivism. The major idea of the theory is that the objects perceived by human beings are constructed by an individual's perception strategies, as well as mental constructions created through the experience. Perception is preceded by the construction, realization of the link between the events. According to the theory, brain not only processes external stimuli, but also adds to it the information from its own knowledge-base acquired from the previous perceptive activities.(John B.Best, 1992)

The Direct Perception Theory opposes to the ideas of Constructivism. The Ecological theory of Gibson can be attributed to the theories belonging to Direct Perception Theory. Gibson claims that the central processes are not necessary for the perception. Sensory stimulation does not need participation of the brain as long as the stimulus itself is highly organized. Our visual system is organized in a way that it cannot notice this invariance. (John B.Best, 1992)

The theory of Piaget provides an interesting attempt to explain the visual illusions. He defines perception generally and perception of illusions specifically through the lenses of genetics. The so called Field Effect is used to explain perceptions. The Field Effect is defined as the initial category of the perceptive activity. Piaget tries to explain the perception from the cognitive-psychological point of view. He claims that any kind of knowledge is distorted by means of different types of "centralisation" and that the objective perception can only be achieved through the "decentralisation." From this perspective, illusions should be described in reference to the normal perceptual processes. The study of illusions is the initial step to study general mechanisms of perception and the ways of its development. (P.Fress&J.Piajet, 1978)

From the theories explaining illusions from the physiological point of view, the paper first of all discusses the Theory of Neuron Shift. The theory argues that the processes occurring in one part of the nervous system may incur inhibition or blocking the processes in the neighboring part. The act of inhibition activity of neighboring neurons by the activated neurons is the result of lateral inhibition. This theory quite successfully explains some simple geometric illusions. However, the theory is itself plagued with vagueness and it fails to explain a large number of illusions. (P.Lindsey&D.Norman, 1974)

As some scientist claim (I.Rock, 1980) the most useful approach to analyze illusions is Gestalt Psychology. According to the theory, while perceiving the world we take into account not only the existence of its elements, but also the relationship between them. We perceive holistic, connected forms which make sense. This is why the whole context and all the stimuli that fall into the visual range influence how we perceive one stimulus. Generally, Gestalt psychology is one of the most successful theories explaining a lot of spatial illusions. As for its idea about the integrity of perception, it is incorporated into the most significant modern psychological studies, which highlight the organized nature of the perception.(I.Rock, 1980)

The researcher of cognitive processes Harvey Shipman summarizes the physiological and psychological theories which attempt to explain spatial illusions. Together with the strengths, the he analyzes their weaknesses as well. Namely, there is no single theory which suggests the all-inclusive explanation mechanism for the spatial illusions. It is highly probable that there is no single process or mechanism able to explain all the known illusions. The author argues that the hypothesis claiming that development of each illusion is connected with several sources is more plausible. The sources are determined partly by the structure of an eye and the neuron processes occurring on the retina, and partly on more advanced cognitive factors such as logical reasoning and past experience. In the framework of this approach, researchers Coren and Girgus suggest an idea which determines two independent levels of perceptual distortion, each of which can participate in the creation of illusory perception. They are titled as optic-retinal and cognitive components. Physiological and anatomic mechanisms of the visual system are acknowledged to be the basis of the optic-retinal components. As for the cognitive components which play a role in creation of illusions, past experience, learning and attention are regarded to belong to this group. Analyzing theories which explain illusions, Harvey Shipman concludes: “the impression made by some classic illusions can be the result of several illusory effects initiated due to different reasons.”(Shipman H. 2003)

All types of illusions mentioned above belong to so called primary illusion. Together with the analysis of the mechanisms of these spatial illusions, it is interesting to pay attention to so called “secondary illusions” (a term by J. Piaget). Secondary illusions are created by the preliminary fixation practice. The example of such illusions is regarded to be set illusions defined by Uznadze. Gestalt theory calls this figural after-effect.

Gestalt psychologist Keller and his assistant Valakh studied in detail test-figure illusory perceptions created after fixation figure (so called figural after-effects). Keller argued that when the retina is irritated by the figure to be inspected, the valley is created which is spread from the center of irritation to the periphery and results in change of the perception of the testing figure (Rock I, 1980). By introducing the notion of field, Keller suggests completely innovative explanation of the figural after-effects. He introduced so called concept of isomorphism. According to the concept, wholeness (gestalt) is considered to be the major principle of existence and basic feature of the universe. The relationship between physical, physiological and psychic events is analyzed based on these principles. The features of psychic are defined by physiological. While perceiving gestalt, the entire process erects in the perception apparatus and eventually spreads to the central sphere by the same form. For instance, if an individual perceives a round object, similar rounded area is created in the brain. As for the physiological gestalt, it is isomorphic to the physical gestalt (physical and chemical processes). Thus, according to the Keller’s concept, explaining the entire psychic means finding relevant process in the brain, which has its corresponding physical process. (Imedadze I, 2004). One of the researchers of perception processes, I. Rock contends that the theory is regarded as quite vague and presents itself as only of historic importance. (Rock I, 1980), 1980). On the other hand, Imedadze, representative of the Georgian psychological school, claims, that the most significant weakness of the theory is the universalization and absolutization of the idea of wholeness. “The studies carried out in the sphere of perception submitted to the idea of hegemony of the whole over the parts. Eventually, it led to failure to understand the role of the parts in determining the whole.” (Imedadze I, 2004).

One of the researchers of secondary illusions using Theory of Uznadze was J. Piaget. It was his work that made Set Effect known as “Uznadze’s Effect.” According to Piaget perceptive activities can be expressed in different ways: simple or polarized movements of an eye, moving the magnitude and transposition in space, moving the direction, anticipation, schematization, etc. In spite of the fact that the majority of the perceptual activities are directed by decentralisation (that

is with maturing the number of perceptive mistakes reduces) frequently the perceptual activities themselves incur new deformation effects (secondary illusions). Unlike the primary illusions, these secondary types of deformation are strengthened with maturing. This happens not due to strengthening the mechanism of deformation (contrast effects), but because the activity directed to determine the interrelationship between them is developed. Notably, Piaget calls the fact explored in the experiments by Uznadze “Anticipated Perceptive Set.” Piaget discovered one interesting fact: “Uznadze’s Effect” is found to be weaker in small children, but it is not eliminated easily – the inhibition process takes place. The contrary is true for adults – the effect occurs more strongly and is more persistent, stronger inhibition process is observed. Piaget concludes that contrast effect is reduced with maturity. The increase of contrast phenomenon can be due to creating temporary links between three expositions of unequal circles and expositions of equal circles. This leads the author to argue that perseveration is more characteristic to children’s behavior than the anticipation. The latter happens later. The anticipation changes the behavior and develops together with the development of the subject, specifically, subject’s intellect. (P.Fress&J.Piajet, 1978).

This short historic review of the theories explaining illusions makes obvious the significance of the issue and importance of the problem for the classical and modern psychology.

A large number of scientists discussed the mechanisms of perceptive illusions from the Set Psychology viewpoint. As Uznadze and other researchers finally confirmed, the consistent illusion is initiated by the influence of the set created in the first part of the experiment. However, the idea considering the set as the basis for perceptive illusions was created earlier in the studies by Fehner, Lange, Muller and Shuman. (Uznadze D., 1938). The difference between the positions of these researchers and Uznadze was of immense importance. They suggested that the Set determining the illusions was to be explained by the peripheral processes. This is why they titled these processes as Motoric or Sensory set. On the contrary, Uznadze with several important experiments justified the position, that the set should be attributed to central rather than local processes (Uznadze D, 1986). His first argument was based on the fact, that the set is formed in absolutely diverse modalities. The modalities may include the spheres which do not have anything in common with the general motoric set. For instance, the set fixation depends on hearing stimulus or pressure spheres. “They all are completely analogous and appear in analogical circumstances” . (Uznadze D, 1938). In order to

explain these illusions, later on Martin together with Muller created new, more general theory known as Martin-Muller theory or theory of “Frustrated Expectations.” The theory contends that the reason for creating contrasting illusions is phenomenal factors – frustrated expectation that they will be given an object of a certain weight. Uznadze criticized this theory as long as it used hypnosis on experiment participants. Despite the hypnotic amnesia, illusory perception still takes place. These experiments confirm that the processes initiating the set are unconscious. This is why illusions cannot be explained by the conscious phenomenon, such as sense of expectation. (Uznadze D, 1938).

In the research it is noted that generalization and irradiation experiments confirm the centrality of nature of the set. Uznadze organized experiments where set was initiated in one corresponding organ (for instance, right eye) and critical objects were presented to another (left eye). It turned out, that all the experiment participants perceived equal critical rounds in contrasting-illusory way. More reliable experiments were intermodal irradiation experiments, where fixation tests were held in one modality while critical tests took place in another. In this case contrasting illusions were observed. Thus, spreading the set or irradiation from one functional system to another happens. This phenomenon would have been impossible if the set was connected with only one process, for example only perceptive or motoric (Nadirashvili, 1983). As for experiments with generalization set, the set is fixed on certain material (for instance square) and in critical experiments the participant is presented with another material (for example, circle). It turned out that the set illusions happened in these circumstances, which confirms the argument that the set is created and is generalized from moving from one material to another (Terumi Ghatani,1984).

Concluding all the above mentioned, the problem underlined in the first part of the paper about the reasons for creating set illusions is successfully solved by the Uznadze’s Set Theory. The basis of Set illusions like all other human behaviors is the set, which is a distinctive psychic phenomenon and its nature cannot be attributed either to subjective or objective phenomenon.(D.Uznadze, 1986)

The set is not a peripheral_process locating in separate organs of humans, but it is a central, wholistic state of subject. This statement is crucial in Unzadze Set Theory. The_ irradiation experiment, is the most important factor to confirm the centrality of nature of the set.. However, there is an opinion suggesting that ”the transmission of the set from one organ to another is not the

most powerful argument to suggest that the set is created in the Center. This is because we cannot eliminate the possibility that the structure of set illusion is created in one peripheral area and transmits to another peripheral area without any important alteration in the center. In this case center plays the transition role” (Chhartishvili, 1963). In addition, Nadirashvili noticed the weakness characteristic to all the previously held experiments. Notably, there were no statistical methods used to make the conclusions reached more reliable and trustworthy. However, only this weakness would not have led to complete refusal from the scientific value of the results of the irradiation experiments. (Nadirashvili Sh., 1983)

But as repeated experiments revealed, intermodal irradiation was not confirmed. Eventually, the situation was created when the Set Theory was left without its most important statement – the empirical evidence confirming the centrality of the nature of the set. The situation was worsened since the studies were conducted in the framework of the School of Set Psychology, revealing the importance of peripheral factors in creating the set. The example of such study is the experiments carried out by Adamashvili. In the study titled as “About the importance of the factor of irritation of retina in creating set in Optical Sphere” the author argues, that the set is manifested more weakly if setting and critical circles fall within different zones of the optical area (Adamashvili, 1953). The study by Adamashvili was improved in terms of technological advancement by the research of Russian psychologist Zinchenco. The study is extremely important due to the fact that it is considered as one of the most reliable and exact experimental confirmation of the hypothesis about determination of set illusions by peripheral factors. By means of special apparatus attached to an eye, it was possible to provide experiment participants with setting and critical objects on the same or different areas of retina. The technology also made it possible to create environments where participants were unable to detect the objects and their traces which fell within their sight. The experiment revealed that contrasting illusion was created quite easily if the setting and critical circles were exposed to the same area of retina. The illusions were not created at all if the exposition area was different. This result points to the fact that the retinal factor is of decisive importance in creating the set. Furthermore, in one series of the experiment the subjects were provided with the setting objects so that they were unable to see them. As for the critical circles, they were exposed to the same areas of the retina. In this case clear contrasting illusions were created too. The author analyzes the results of his experiments from the perspective of Activity Theory and claims that “the results confirm that it is absolutely possible to fixate set not on the level of the subject, but rather on

the level of an object... based on the study the conclusions were made about the existence of hierarchy of the perceptive set. The hierarchy includes elementary set created on the periphery of the receptor and more complicated, which requires participation of central processes.” Zinchenko specifically highlights the fact, that the sets fixated on the lowest level of the hierarchy influence the mechanisms of activity. Eventually, in his paper he uses functional state as a term to refer to the set. He attributes more wide and general meaning to the term of functional state, which can be used while interpreting and analyzing the mechanisms of fixating the set. However, he does not prefer functional state over activity and lastly he accepts the major statement of the activity theory claiming that any behavior of a subject may be determined by the activity (Zinchenko V.P., 1978).

Paragraph shortly reviews the fundamental statements of the Activity Theory, which opposes to the Set theory. Namely, it discusses the hypothesis proposed about the hierarchical levels of the set which was proposed by one of the representatives of the Activity Theory, Asmolov. As the researcher states, the activity is not the result of set, rather the set follows the activity. The problem exists in defining the role of the set in the activity of an individual. According to Asmolov, this depends on the level of activity an individual is functioning at. In relevance to the basic structural units of the activity (activity, action, operation, psycho-physiological mechanisms – receptors of the action) there are the following levels of the set – conceptual, goal, operational and psycho-physiological mechanisms – receptors of the set. Each level has the specific characteristics prevalent to it (Asmolov, A. G., 1978).

Some scientists also discuss the experiments which, unlike the above-described studies, point out the phenomenal factors in initiating set illusions. Among such experiments one of the most important are the ones conducted by Natadze on set created due to imagination. In these experiments the subjects created contrasting illusions on the basis of pure imagination. The second part of the experiment is especially interesting. In this part, the subjects were given equal balls and were asked to imagine that they were holding bigger ball in one hand and smaller in another. In this part the set was created. However, the author points out the excess of the assimilative illusions. This experiment is interesting since in case of objective equivalence of the balls the set was created only due to unequivalence in imagination. But as noted above in the case of intermodal irradiation, the inexistence of statistical analysis of the data imposes serious doubt over the reliability of the conclusions of the experiment. As for the fact, that accompanying the experiment with the

movement of a hand increased the amount of contrasting illusions, it indicated the important role of the retinal factor.(Natadze R , 1963)

The same reasons make unreliable the experiments conducted by Tsintsadze which were implemented under the unequivalence created only in the feelings. For the setting objects he use Sharpantie and geometric-optical illusions, namely, Muller-Lyer, Zander, Debef and Tselner illusions. These illusions were provided to the subjects in the setting tests.; then by means of illusions the set was fixated in the critical test, where they were given relevant equal objects (for example, in case of Muller-Lyer illusions this was equal lines, in Zander's illusions – proportional triangles, in Debef's illusions equal circles and so on). Despite the real and hypothetical retinal equivalence in sizes of the setting objects, critical objects were perceived as unequal by the subjects. That is, the set formed was expressed in the contrasting-illusory form. Hence, the author concludes that the set is fixated with regard to the phenomenal magnitude regardless the fact that the sense is illusory or not. However, as Tsintsadze points out the set formed due to illusory perception is harder to form and more static in comparison with the set formed by the real stimuli. Like in case of phenomenal set fixation, in this case the excess of assimilative illusions are to be observed. If the weaknesses of the statistical analysis conducted are taken into account, the findings of the experiments are quite doubtful(Tsindtsadze K, 1966) However, these findings were confirmed in the analogous experiments conducted by Japanese researchers who used more advanced electronic equipment and the findings were tested using statistical methods. In these experiments about 70% of contrasting illusions were achieved (Takai L, 1984). In spite of the assumption that these experiments seem to confirm the fact of fixating the set illusions only by means of phenomenally unequal objects, the existence of retinal factor cannot be eliminated fully. This conclusion is more trustworthy since as we reviewed theories in the first paragraph, geometric-optical illusions can be initiated by the retinal factors. This means that change in the parts of the figures is impressed on the retinal level also and not only in the subject's sense. Hence, we are deprived of the right to speak about set formation only due to phenomenal unequivalence.

The paper also reviews several other experiments which oppose to the assumption that setting illusions are to be explained only by peripheral processes. Each of them is characterized with the original methods used, but all of them share the principle which was used for justification of the arguments. More specifically, the test conditions were organized so that if the set was formed in peripheral area then in the critical test it was expressed in one direction and if the set was formed in

central area, then it was expressed in another direction. The findings showed that the set is formed in the center, which confirmed the central determination of the set (Chkhartisvili Sh.& Tabidze O, 1963; Kumiko Kikutani, 1984). One of the representatives of the Set Psychology, Chkhartishvili notes that although the experiments reveal the set is not conditioned by the peripheral processes, like processes that occur on the retina, still the assumption that the set is conditioned by the central physiological processes need more proof in the sphere of physiology.

In the last part of the paragraph the paper focuses on one more important study in the field of factors determining set illusions – Regularities on set Formation and Function on Different Levels by Adamashvili (Adamashvili N., 1960). The findings of the author are somewhat compromise between the theories explaining set formation with retinal and phenomenal factors. “The level of set exposure in case of divergence of retinal and factual sizes of the critical circles belongs without exception to some middle level, which is only possible in case of influence of both sizes. Set expressions depends both on the retinal and factual sizes of the critical circles... the most important thing is the optimal size.” (In this case factual sizes coincide with sensed sizes) (Adamashvili N., 1960).

To conclude all the above mentioned, the experiments reviewed above regardless the variability they present can be characterized with one single component. All of them attempted to define the role of either retinal or central factor in the set fixation. However, the findings are contradictory. Furthermore, all of the experiments share one important weakness – the conclusions cannot be regarded as valid and reliable due to the deficiencies of the statistical apparatus used to analyze the data.

Chapter 2. Experiments

The aim of our research is to compare sets formed on the three different levels: first, it is the set fixed on the sensory unequivalence (in condition of phenomenal equivalence); second, it is the set fixed on the phenomenal unequivalence (in condition of sensory equivalence) and the third, it is the set fixed on both sensory and phenomenal unequivalence. (The set was fixed according to the traditional method adopted in Uznadze Psychological School). In addition, we attempted to define the role of retinal and phenomenal factors in formation of set illusions.

In this chapter it was reviewed 4 major experiments, series of these experiments, one preliminary and one additional experiment. One of the paragraphs is fully dedicated to the comparative analysis of the results

1. Experiment 1.

The aim of 1st experiment was to describe the specifications of the set fixated through retinal unequal objects.” The first experiment tested two hypotheses:

1. It is possible to fixate the set with retinally unequal objects (in condition of phenomenal equivalence), which in critical tests reveal as contrasting comparison of the equal objects. In order to test this hypothesis I a series of experiment was conducted.
2. The strength of the set fixated with retinally unequal objects is the function of retinal unequivalence. Therefore, alteration in amount should incur the change in manifesting the fixated set. Namely, it should be expressed in the increase of contrasting illusions. For this purpose the I b and I c series of 1st experiment were carried out.

Method

The research method is described in detail since it is common to all other experiments with some slight variations which obviously will be described below. The detailed description of the apparatus especially designed by professor Qiria at Ivane Javakhishvili Tbilisi State University, Department of Work and Organizational Psychology is given below.

Apparatus: It is parallelepiped-shaped box (112cm, 45cm, 50cm); its inner surface is covered with black clothes. There is a peeping window in the front wall of the box for observation by a subject.. The subject was exposed with the fixation point (small luminous bulb) on the center of

the box and two luminous objects to the left and right of it. These objects were circles S1 and S2, their diameters were equal ($d_1=d_2=7\text{cm}$). In the second series left circles S1 were replaced by S3 circle ($d_3=4\text{cm}$). The circles S1 and S3 were (fixed) unmovable; they were located at 37 cm distant from subject; the circle S2 was movable. The distance between circle S2 and subject varied by around 50cm (minimum distance is 37cm and maximum one is 87 cm). Subjects could change this distance themselves.

Subjects.

The subjects were 160 subjects who were students and staff at Ivane Javakhishvili Tbilisi State University aged 17-35, both male and female.

Procedure.

Uznadze method

For investigation of set, we adopted the method of the fixed set developed by Uznadze. Equal and unequal circles were flashed for 0.5 s at time intervals of 3s. The subjects were presented with two circles of unequal sizes for set formation. This was called set tests. After the set tests a subject was presented with two equal circles and asked to reply, which seemed larger? This was called the critical tests. Following several exposures of the unequal circles the subject presented with equal circles, perceived them as larger or smaller in comparison with those presented in the set formation. This perceptual distortion called set illusion, represents a fixed set in accordance with the preceding set tests. The presentations were carried out in the following manner:

set tests(15 trials);

critical tests (40 trials).

Figures presented in the control, in the set and in the critical tests were called the control, the set and the critical figures, respectively. The control and the critical figures were the same consisted of the same-sized circles. Each subject was instructed to fixate a small red point that was exposed as the fixation point in the center of the stimulus field. The subject was instructed to use three terms, "left", "right" and "uncertain or equal" in order to tell which circles seemed larger.

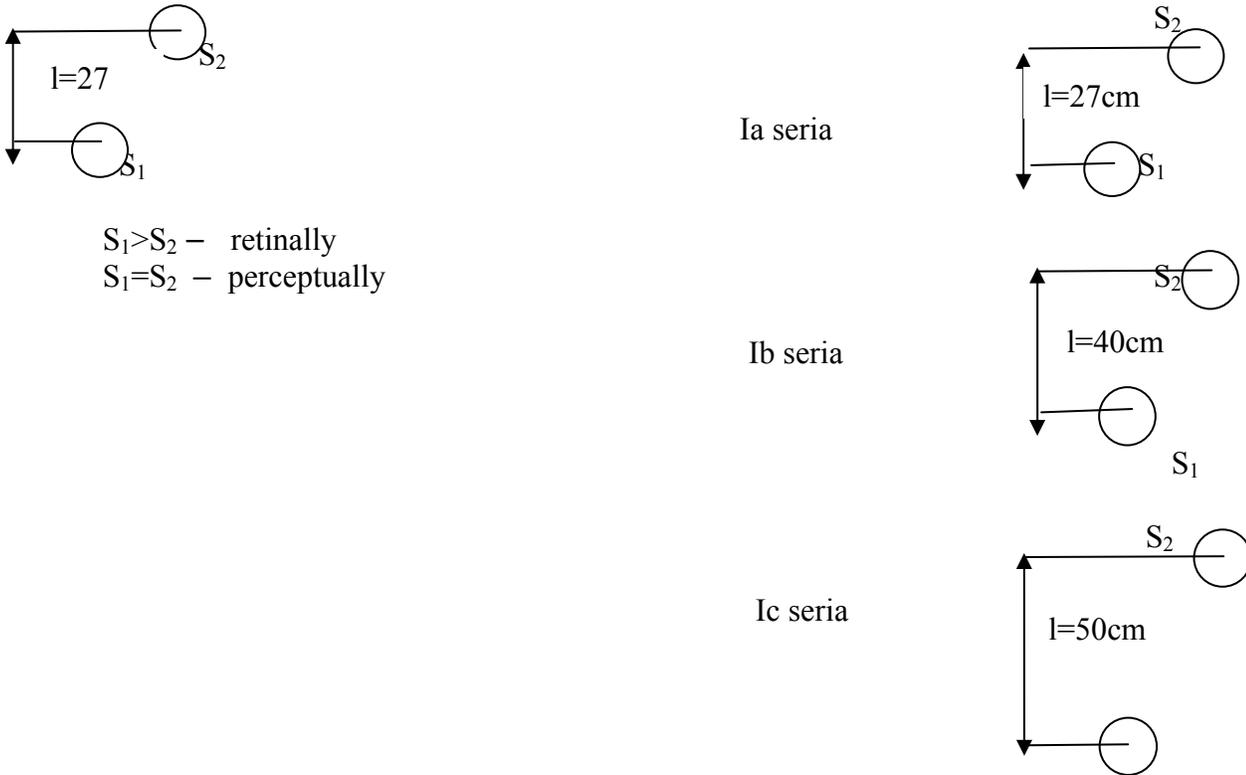
Generally, the design of the experiment was analogous to the design of classical experiment of Uznadze: after 15 setting exposures, for estimation the subjects were presented with critical equal objects. The following scheme of grouping subjects was used. There were two groups of subjects: control group consisting of 40 subjects, and experimental one involving 120 subjects. This scheme

was used to test null hypothesis. We were interested to see how the sizes of equal objects would be estimated without creating experimental conditions. The independent variable was the setting exposure. That is multiple replication of exposure of the retinally unequal objects. The dependent variable was the estimation of the equal objects by the subjects. The researcher use two levels of manipulation with the independent variable: with the setting objects and without them. In the controlling set the subjects were not exposed to influence of experimental factor, more exactly they were not presented with the setting objects. The subjects were estimating only the equal objects. The subjects in the experimental group were estimating the same equal objects following the multiple exposures to the unequal setting objects.

The second significant difference from the traditional experiment of Uznadze was the condition that in the setting tests subjects were presented with factually equal objects which were phenomenally equal. However, these figures (in this case circles) were retinally unequal. How was the retinal unequivalence of setting objects achieved under conditions of their perceptual equivalence? For this purpose the phenomenon of Perceptual Constancy was used, which indicated the ability to perceive the factual magnitude of an object regardless the change in the image retinally. This is why, if we move one out of two equal objects – increase the distance, the object's retinal size would seem smaller than that of a nearer object. However, these equal objects would be phenomenally perceived as equal. This is the strategy to achieve retinal unequivalence under the condition of perceptual equivalence.

The basic tests were preceded by the preliminary tests, during which subjects were tested for the individual level of Perceptual Constancy. The purpose is to determine the range where the subject perceives proximally unequal but phenomenally equal objects as equal. This procedure was necessary in order to conduct setting tests in this range. We have to make sure that in the tests conducted the set was exclusively formed by retinally unequal objects (in condition of their phenomenal equivalence). This preliminary procedure ensured that only those subjects participated in the experiment whose individual constancy range was not less than 27 centimeters for the I a series, not less than 40 centimeters for the I b series, and not less than 50 centimeters for the I c series. In the 1st experiment the design of I b series were identical in the design to the I a series. The only difference was that the distance between the objects was 40 centimeters in I b series, and 50 centimeters in I c series. 20 subjects participate in each series.(see Figure 1)

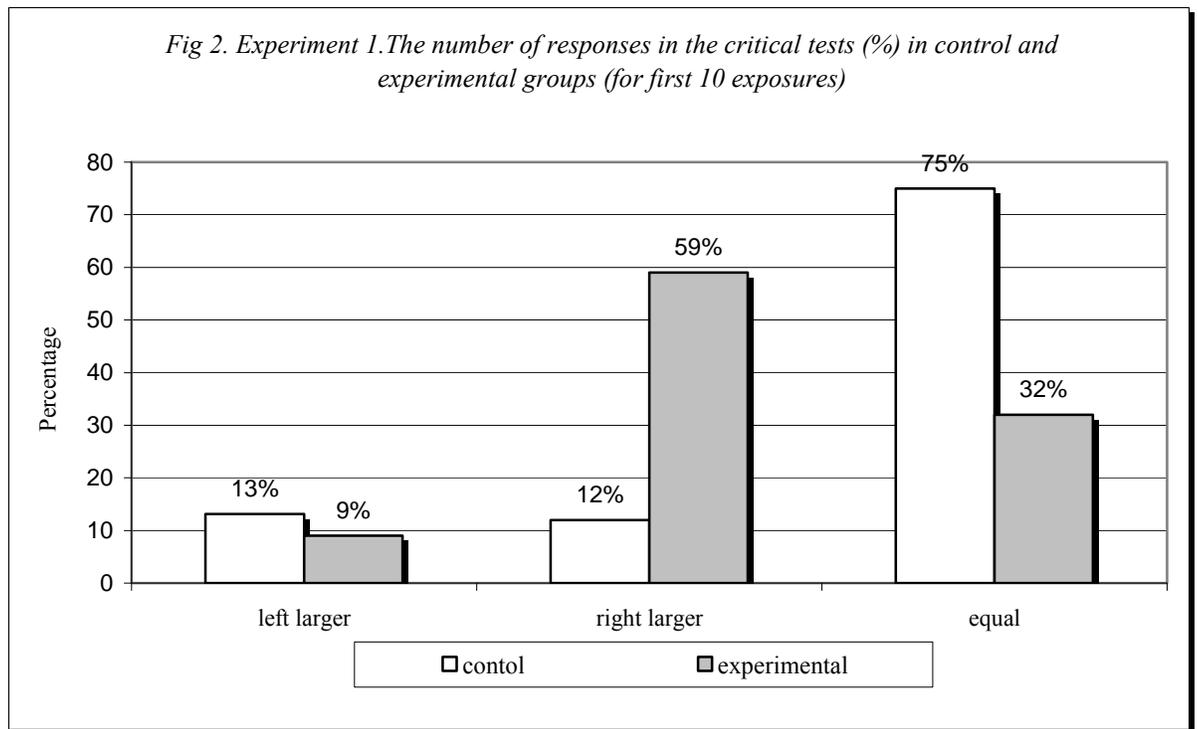
. Fig.1 The design of Experiment I : the change retinal unequivalence of equal circles by increasing the distance between them



Results and Discussion

In analyzing data from the I a series of the Experiment 1 the comparison between the frequencies of contrasting, assimilative and equivalence responses in control and experimental conditions revealed that by Pearson's tests the distribution was significantly different from each other ($\chi^2=274.8$, $p<0.0000$, d.f.=2). This means that the results of control and critical tests differ from each other and the estimation in critical tests should be conditioned by the contrasting illusion. The Figure 2 clearly shows the difference in distribution of frequencies of the results in the control and critical groups. In order to control for the extraneous variables, only 10 results of critical exposures of each, control and critical tests, are counted. The same method is used by the researchers of University of Osaka to conduct set experiments.(Isamu Kawaguchi , 1984). Using this method by us is conditioned by another reason as well. Based on various studies in set psychology, it is widely acknowledged that the initial phase of the set is most stable and strong. This

is why it is more important and interesting to compare the results of this initial phase with the results of control tests. (KvavilaSvili J., 1960)



The strength of the illusions was 7.67. The mean of assimilative illusions was 2.73. The difference between the means of contrasting and assimilative illusions proved to be reliable ($t=5.478, p<0.001, d.f.=119$)

Thus, the results obtained from the experiment proved the first hypothesis: under the condition of unequivalence of retinal size of setting objects and perceptual equivalence it is possible to fixate the set, which was manifested in the change of the amount of contrasting illusions in comparison to control tests. This fact can be explained by the changes occurred in the setting tests.

As for the comparison of the results of the series I a, I b, and I c, from the Figure 3 it becomes obvious that with the increase of the distance of the setting objects, the number of contrasting and assimilative illusions increase.

The results obtained are shown in the Figure 3 and in the Table 1.

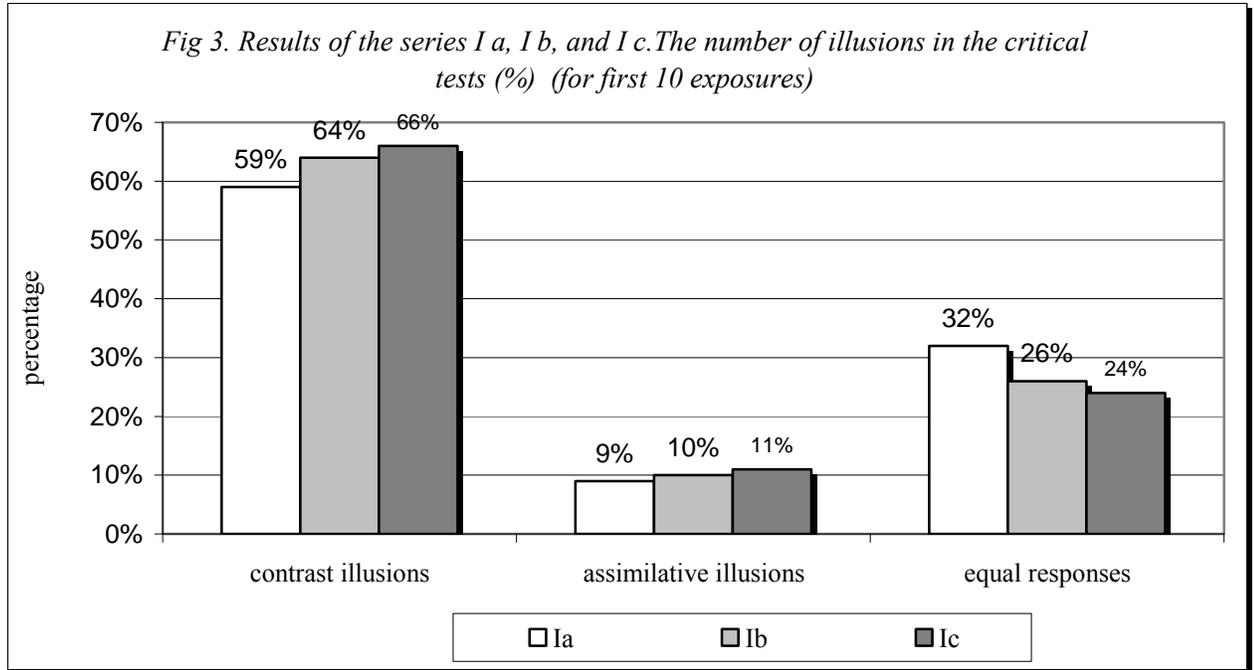


Table 1. The results of the series Ia, Ib and Ic.

| series | the distance between objects | the difference between distribution of frequencies of illusions- χ^2 |
|------------------|------------------------------|---|
| Ia and Ib series | 27 cm | $\chi^2=6.02$ · $p<0.05$, d.f.=2 |
| Ib and Ic series | 40 cm | $\chi^2=1.78$ · $p>0.5$, d.f.=2 |
| Ia and Ic series | 50 cm | $\chi^2=15.51$ · $p<0.005$, d.f.=2 |

Thus the results proved the *second hypothesis* as well: the change in the amount of retinal unequivalence results in increase of the contrasting illusions of the fixated set.

2. Experiment 2.

The aim of the second experiment was to study the characteristics of the set fixated with the phenomenally unequal objects. The third hypothesis was tested:

Under the condition of retinal equivalence phenomenally unequal objects can fixate set, which is manifested in the critical tests as the contrasting estimation of equal magnitude.

Method

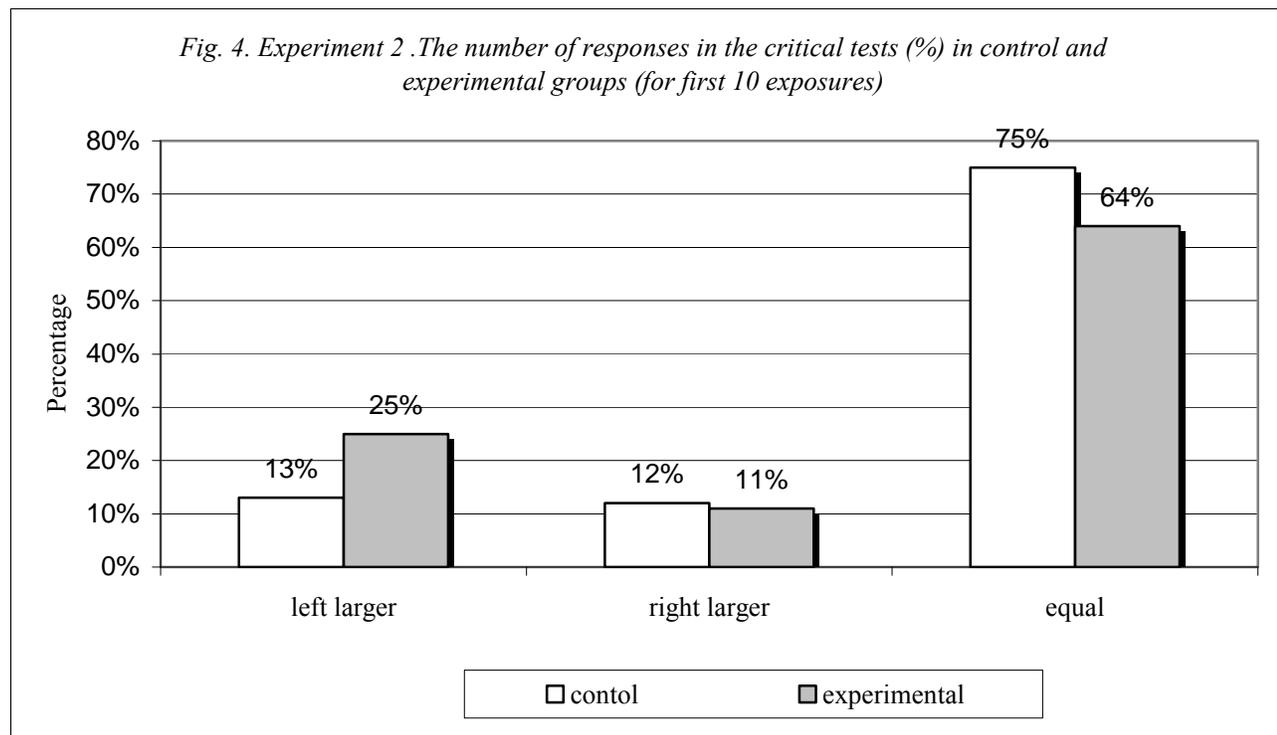
There were 90 subjects participating in the second experiment. The design of the study was analogous to the first one. The only difference was that in the setting tests instead of objectively equal circles, which were different on the retinal level, the subjects were presented with the circles of different sizes, which had equal retinal sizes. The equivalence in retinal size was achieved by moving larger circle further in the distance, which resulted in decreasing the size of the image on the retina. At certain distance the bigger circle seemed of the same size as smaller circle. If this distance fell within the range of the individual constancy of the subject the object seemed bigger for them than objectively smaller circle. However, the retinal size of the objects was the same. This is the strategy to achieve the condition of the experiment – the retinal equivalence in the condition of perceptual unequivalence. This distance was calculated under the conditions of the invariance of magnitude and distance using mathematical formula: $\text{tga} = S/2l$; where a is the visual angle (retinal projection), S – visible (and objective) magnitude of the object, and l – visible (and objective) distance. Thus, the distance by which larger circle should have been located from the smaller one was 27 centimeters. This was the distance used in the first experiment series I a for locating one circle from another which were of the same size. Since the conditions of the first and second experiments were identical, this approach was used to avoid influence of extraneous variables.

Results and Discussion

While conducting the analysis of the results of the second experiment, the distribution of the frequencies of contrasting, assimilative and equivalence responses of the control and basic tests by means of Pearson's χ^2 tests revealed that this distribution is statistically different from each other ($\chi^2=23.93$ $p<0.0001$ $d.f.=2$). This means that the results of the control and critical tests are different from each other and in critical tests majority of the estimation to the left is conditioned by the contrasting illusions. Figure 4 provides the results, which reveal the difference in distribution of the frequencies of the results of control and critical groups.

The mean of contrasting illusions or the strength of the illusions equaled to 3.86. The mean of assimilative illusions was 2.45. The difference between the means of contrasting and assimilative illusions turned out not to be reliable ($t=1.503$, $p>0.05$, $d.f. =89$).

Therefore, our third hypothesis was proved – it is possible to fixate the set by means of phenomenally unequal objects under the conditions of retinal equivalence, which are manifested in the critical tests as contrasting estimation of the equal magnitudes. However, it should be noted that the strength of the set is extremely weak.



3. Experiment 3.

The aim of third experiment was to study the features of the set fixated through perceptually unequal objects.

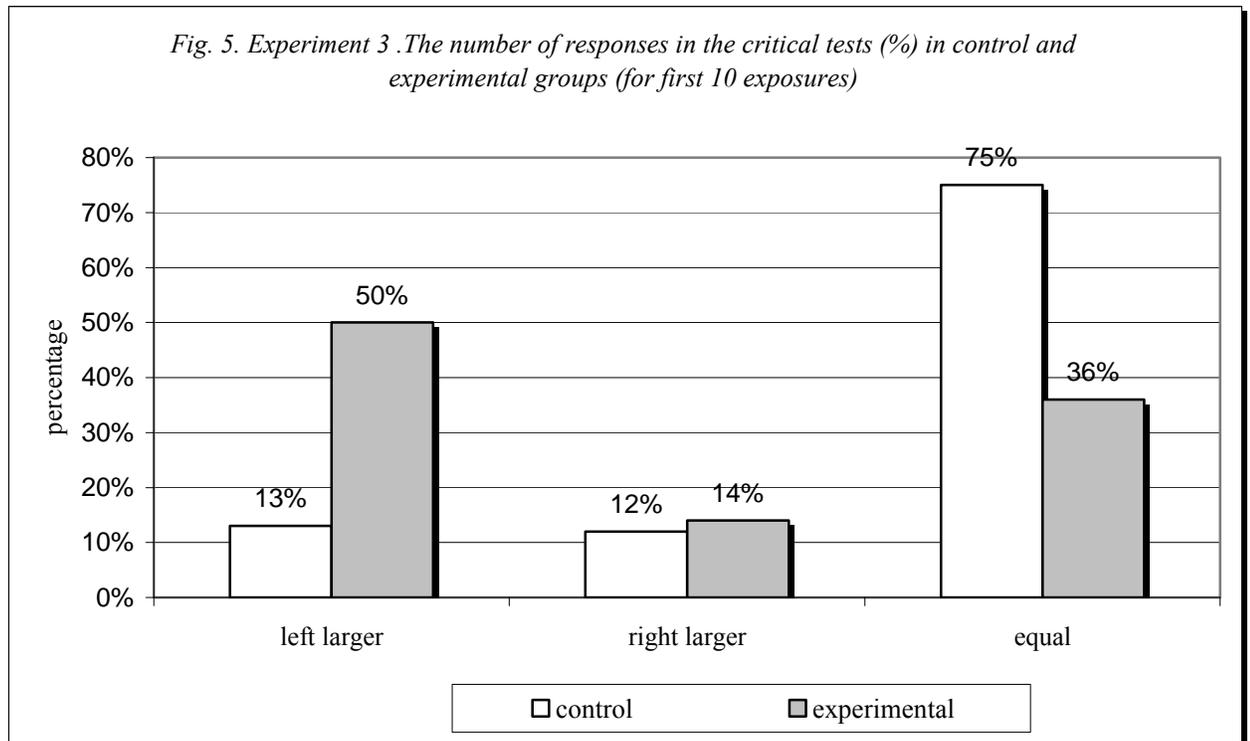
Method

In this experiment the set is fixated using the traditional scheme of Uznadze: the subjects in the setting tests are given big and small circles. Unlike the first two experiments, the objects are unequal both retinally and phenomannally. In his experiment the objects were located next to each other and were presented at the same distance from the subject. Otherwise the conditions of the third experiment were analogous to the first and second experiments.

Results and Discussion

As anticipated, while analyzing of the results of the third experiment, the distribution of the frequencies of contrasting, assimilative and equivalence responses of the control and basic tests by means of Pearson's χ^2 tests revealed that this distribution is statistically different from each other ($\chi^2=90$, $p<0.00001$, d.f.=2). This means that the results of control and critical tests are different from each other and in the critical tests the large amount of the estimation to the right is conditioned by the contrasting illusions.

Figure 5 shows the results. It is obvious that there is a difference in distribution of the frequencies of the responses in the control and critical groups.



The mean amount of contrasting illusions, that is the strength of the illusion, was 8.48. The mean of assimilative illusions was 2.25. The difference between the means of contrasting and assimilative illusions was found to be reliable ($t=3.540$, $p<0.002$, $d.f=24$).

3. The comparative analysis of the results of all three experiments

The comparative analysis of the results of all three experiments in which the set was formed retinally, phenomenally and perceptually using the classical scheme was performed. In addition, it provides the review of some additional experiments, which aimed to study the constancy of the sets fixated by three channels.

In this paragraph the *fourth hypothesis* was tested:

If in case of the comparison of the set fixated through the retinal and phenomenal channels with the set fixated by perceptually unequal objects it is revealed that they are alike in terms of formal-dynamic characteristics, this would be an additional evidence that they have common characteristics of action; the fixated set is central, wholistic, phenomenon in formation of which retinal and phenomenal factors play equally important role.

The comparison of the sets fixated through the different channels was conducted according to the distribution of the responses of the subjects and the features of the strength of the set. Table 2 provides the results of this comparison.

Table 2. Comparison of the set fixated through different channels according to distribution of frequencies of contrasting, assimilative and equality responses, and strengths of the set.

| Experiments | the difference between distribution of frequencies of illusions χ^2 | the difference between means of strength of set (t test) |
|---|--|--|
| Experiment 1 and Experiment 2: set fixed by retinally and phenomenally unequal objects | $\chi^2=180.77, p<0.0000, d.f=2$ | $t=3.30, p<0.002, d.f=.208$ |
| Experiment 2 and Experiment 3: set fixed by phenomenally and perceptually unequal objects | $\chi^2=727.3, p<0.0000, d.f=2$ | $t=4.3, p<0.0001, d.f=113$ |
| Experiment 1 and Experiment : set fixed by retinally and perceptually unequal objects | $\chi^2=3.69, p>0.1, d.f=2$ | $t=0.304, p>0.5, d.f=143$ |

As the Table 2 shows, the characteristics of the retinal set are similar to the features of the set fixated through classical scheme. As for the set formed by phenomenally unequal objects, it differs from both retinal and perceptual set. It has the least strong set. Based on this, we can assume that the set fixated by means of traditional scheme of Uznadze, retinal factors play a leading role in forming the set illusion.

The dissertation further elaborates on the relationship between differential-psychological features if the set fixated by unequivalence objects retinally, phenomenally and perceptually. In this regard, the paper reviews the strength of the set and how it is extinguished. Out of 120 subjects of the 1st experiment, 80 participated in the 2nd experiment as well. It was found that the indices of the strength of the set fixed by retinally and phenomenally unequal objects are positively correlated. This means that the subjects who formed strong set through retinally unequal objects revealed the same strong set formed through phenomenally unequal objects as well (the Spearman's rho (correlation coefficient) $r=0.46, p<0.005, d.f=80$). From the 25 subjects participating in the 3rd experiment 20 participated in the 1st and 2nd experiments as well. Analogously, the correlation was found to be positive between the sets fixated by retinally unequal objects and the set formed through

traditional schemes ($r=0.42$, $p<0.01$ d.f.=20.). The same is true for the set formatted through the classical scheme and the set fixated by phenomenally unequal objects ($r=0.4$, $p<0.02$, d.f.=20).

It is acknowledged fact that the process of extinguishing the fixated set does not proceed in the same way even in one modality and different types of extinguishing the set can be manifested by the same subjects. This is the reason why the dissertation pays certain attention to the following issues: how constant is the extinguishing type in the sets fixated by retinally and phenomenally univalent objects; whether or not the distribution of the percentage of the extinguishing type is similar to the distribution revealed in the set fixated by classical scheme. Generally, subjects with variably types of set are rarer than constant types. Among the constant types the percentage of subjects with dynamic set types are larger than that of static types. This issue was studied by additional experiment and it was found that the distribution by percentage of the types of extinguishing the set fixated by retinal set is the same as in the case of the perceptual set. The variably type of extinguishing is more frequent in the sets fixated by means of phenomenally unequal objects. Table 3 shows the results obtained from the experiment.

It was found that the difference between the distribution of the set types of the sets fixated by retinally and phenomenally unequal objects is statistically reliable ($\chi^2=7.9$, d.f.=3, $p<0.05$). Statistically reliable was the difference between the distribution of the sets fixated by phenomenally and perceptually (set fixated by traditional scheme) unequal objects ($\chi^2=10.45$, $p<0.01$, d.f.=3). The set fixated by retinal factors was found the same as the perceptually fixated set ($\chi^2=0.5$, $p>0.9$, d.f.=3).

Table 3. *The distribution by percentage of dynamic, static and variably types of the sets under conditions of the fixated by retinally, phenomenally, and perceptually fixated sets.*

| set types (by set extinction process) | | | | | | |
|---------------------------------------|--|--------|---|--------|---|--------|
| | set fixed by retinally unequal objects | | set fixed by phenomenally unequal objects | | set fixed by perceptually unequal objects | |
| | % | number | % | number | % | number |
| dynamics | 50.00% | 15.00 | 16.67% | 5.00 | 55% | 11.00 |
| static | 10.00% | 3.00 | 10.00% | 3.00 | 15% | 3.00 |
| variably | 23.33% | 7.00 | 40.00% | 12.00 | 20% | 4.00 |
| no illusion | 16.67% | 5.00 | 33.33% | 10.00 | 10% | 2.00 |

Eventually the fourth hypothesis was not proved. It was found that there is more similarity in terms of formal-dynamic characteristics between the sets fixated by retinally and perceptually unequal objects, than it is between these and the sets fixated by phenomenally unequal objects. More obvious is the difference in the number of contrasting illusions, which in the experimental set psychology is considered to be the criteria of manifestation of the set. The obtained results indicate the dominant role of the retinal factor in formation of set illusions.

Experiment 4

The aim of Experiment 4 was to study the strength of the set fixated by retinally unequal objects as the function of the differences between the angle magnitudes of the setting objects.

The following hypothesis was tested in this part:

The strength of the fixate test is the function of the difference between the angle magnitude of the setting objects and not the function of the difference manifested phenomenally.

Method

The setting objects of this experiment were objectively different small and large circles located at the various distances from the subjects. Moreover, objectively larger circles were located at the larger distance than the smaller ones. Thus the size of retinal image or in other words angular

size of the larger circles was smaller than those of the smaller objects. Phenomenally large-small objects were retinally small-large objects. Subjects were under the influence of two experimental factors of different directions. One acted in the direction of the set fixated by phenomenally unequal objects and another in the direction of the retinally fixated set. Thus, in this experiment the assimilative illusions formed by the set fixated by phenomenally unequal objects at the same time coincided with the opposing contrasting illusions of the retinal set. It was interesting to observe what influence the increase of retinal unequivalence (not expressed phenomenally) would have on the subjects' responses; on the contrary the unequivalence was expressed in opposing direction.. For this purpose the series IV a and IV b were conducted. In the experiment IV a the larger circle was located 40 centimeters further than the smaller one from the subject; in IV b the difference in distance was 50 centimeters.

Results and Discussion

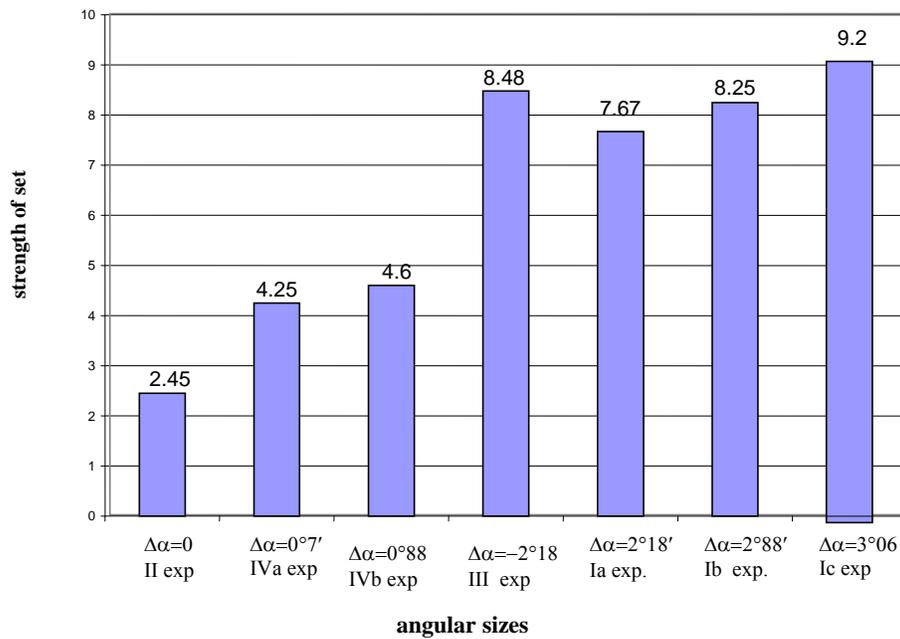
The difference between the distribution of the responses in the 2nd and 4th experiments was found to be statistically reliable (between the 2nd experiment and series IV a – $\chi^2=43.97$, $p<0.0000$, d.f.=2; between the 2nd experiment and series IV b – $\chi^2=57.3$, $p<0.0000$, d.f.=2). It turned out that the difference in distance (10 cm.) was not enough to incur changes in the fixated set. The results proved that the increase in retinal size influences the manifestation of the set. Despite the condition, that in the setting test subjects perceived larger circles to their right (the retinal size of which were smaller), the number of estimation was more on the right in the critical test, meaning that assimilative illusions were increasing and contrasting illusions were decreasing respectively. This process influenced the changes in the characteristic of the strength of the set. The results are presented in the Table 4.

Table 4. *The indices of strength and the means of assimilative illusions in set fixed by phenomenally unequal objects*

| Experiments | the indices of strength of set (the means of contrast illusions)) | the means of assimilative illusions |
|---|---|--|
| Experiments 2(the distance between S_3 and $S_2=27$ cm) | 3.86 | 2.45 |
| IVa seria (the distance between S_3 and $S_2= 40$ cm) | 2.7 | 4.25 |
| IVb seria ((the distance between S_3 da $S_2= 50$ cm | 2.5 | 4.6 |

Eventually, it is not easy to determine which factor influences the obtained results if both of the factors are in place simultaneously. However, certain conclusions can be drawn if the changes in angular magnitude of the circles are analyzed in reference with the expressing of the set effect. Figure 6 provides the graphic representation of the relationship. The difference of the angular size of the circles used in the experiments is indicated by Δ .

Fig.6 The strength of set fixed by retinally unequal objects as a function of the difference of the angular size of the circles



Thus, the fifth hypothesis proved to be true: the increase of the angular magnitude incurs the increase of the effects of the set fixated by the retinally unequal objects regardless how they are reflected sensorogeniously. The results confirm our assumption that retinal factor play dominant role in fixating the set. However, we should not neglect the fact that under conditions of retinal equivalence and purely phenomenal unequivalence (2nd experiment) set can be still fixated. But this set is much less stronger than in case of the set fixated by the retinally unequal objects.

Summary

1. It is possible to fixate the set by retinally unequal objects, which is manifested in critical tests as the contrasting estimation of the equal magnitudes.
2. The strength of the set fixated by retinally unequal objects is the function of retinal unequivalence. Therefore, change in the amount infers change in the manifestation of the fixated set.
3. Under the condition of retinal unequivalence it is possible to fixate the set by the phenomenally unequal objects, which is manifested in the critical tests as contrasting estimation of equal magnitudes.
4. If fixating set by retinally and perceptually unequal objects the difference between the contrasting and assimilative illusions is larger than while fixating the set with phenomenally unequal objects.
5. The distribution of frequencies of the responses of the subjects was not different while fixating the set with retinally and perceptually unequal objects.
6. The characteristics of the strength of the set fixated by the retinally and perceptually unequal objects are more than the characteristics obtained by the phenomenally unequal objects.
7. The characteristics of the strength of the set fixated by the retinally and perceptually equal objects do not differ from each other.
8. It was found that the characteristics of the set fixated by retinally, phenomenally, perceptually objects are positively intercorrelated. This means that the subjects who formed strong set by retinally unequal objects maintained similarly strong set fixated by the phenomenally and perceptually unequal objects.
9. There is a difference in the distribution of percentage of the set types which are fixated retinally, phenomenally, and perceptually. Dynamic type rather than variability type of the set is more characteristic to the sets fixated by retinally and perceptually unequal object. The opposite is true to the set fixated by phenomenally unequal objects.
10. the increase of the magnitude of the angles of the setting objects results in the increase of the effects of the sets fixated by retinally unequal objects. This is true even in the cases when the magnitudes are reflected phenomenally in the opposing

direction. This means that phenomenally large-small objects are perceived as retinally small-large objects.

The formal-dynamic characteristics of the set created by retinally unequal objects and the set fixated by traditional scheme have more in common than the set fixated by phenomenally unequal objects. Moreover, the increase of the angular sizes of the setting objects result in the increase of the set effects fixated by retinally unequal objects regardless their phenomenally reflection. The results obtained from the research confirm the dominant role of the retinal factors in formation the set illusions.

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