V Congress of Russian Psychological Society

Experimental Testing of “Double Overturn” Method: Investigation of Visual Image Formation

Gysev Alexey Nikolaevich, Arbekova Olga Alexandrovna

Lomonosov Moscow State University, Mokhovaya st. 11/9 Moscow 125009, Russia

Abstract

The purpose of this research was to develop a technique of image genesis study. A new “double overturn” method makes it possible to study the interaction between the meaning and the sensory fabric in the process of image formation. 58 participants looked through the invertoscope on the overturned visual scene. The observers saw a normally oriented scene, but they could rethink the perceived image in case of obvious conflict between the sensory fabric and the meaning. Experimental manipulation with the personal meaning of one component of the presented scene led to the illusory transformation of the image.

Keywords: inverted vision, image formation, sensory fabric, meaning, personal sense, visual illusions.

1. Introduction

Visual image formation is a simultaneous and rapid process. This feature is difficult for observation. One of the approaches to study visual image formation is the creation of artificial barriers to the normal process of image progress [1], [2], [3], [4], [5]. It can be achieved by means of special optical devices which distort the proximal stimulus by lenses and prisms, for example, invertoscope and pseudoscope. The proximal stimulus transformation provokes the perceptual conflict which expands the process of image formation and helps us to observe its genesis.

The classic works of American psychologist John M. Stratton [6], [7] initiated research of inverted vision, which was later extended by other authors (Sperry [8], Snyder, Pronko [9], Kohler [10], [11], Howard [12], Harris [13], Yates [14]). The method of inversion has an important advantage because the dynamics of image formation is realized by an observer and at the same time it is not available for conscious control.

To explain our results we use the concepts proposed by A.N. Leontiev [15]. According to Leontiev ’s activity approach the structure of conscious image (percept) consists of 3 components: sensory fabric, meaning and personal sense. Sensory fabric is the system of all human sensations of different senses. These images differ...
according to their modality, sensory tone, degree of clarity, greater or lesser stability. Meaning is a generalized reflection of the most important properties of an object. Personal sense reflects the personal significance of the object for a concrete subject, in the words of A.N. Leontev "meaning to me". Instead of meaning the personal sense does not have its own "supraindividual," “nonpsychological” existence [15].

In the famous experiments with inverted vision there is an opposition of sensory fabric and meaning of visual percept. A new elaborated method “double overturn” allows us to separate the three mentioned above components. The main idea of the method is that the participants looked through the invertoscope at the scene overturned for 180°. Did the participants notice that they looked at the "inverted world"? The first hypothesis of our research was: if there is no conflict between the sensory fabric and the meaning of the perceptual image the observers did not notice the scene was really overturned.

The next step was to “break” the participant’s confidence that the stimulus was ordinary, and to understand how this could be achieved. So according to the second hypothesis, in order to encourage the participant to rethink the meaning of image, you need to collide sensory fabric and meaning. What was more efficient for this purpose: to include additional visual information or information of haptic modality? We supposed that the participant would notice the overturn more frequently in the case of his own action in the space of the inverted room.

The final part of the research studies the role of personal meaning in the image formation with the help of inverted vision and the “double overturn” method. The third hypothesis deals with the role of personal meaning in the image formation. Could the additional personal meaning of one component of the perceived scene influence the illusory transformation of the image?

So there were two primary goals in the research. One of them was to work out the method for laboratory research of visual image formation. The other one was empirical – to study visual image formation in conditions of inverted vision and the role of sensory fabric, meaning, personal sense in this process.

2. Method

2.1. Participants.

29 women and 29 men aged 16 to 30 years participated in the research.

2.2. Apparatus, stimulus and tools.

Each respondent looked at the visual scene through the lenses of the invertoscope. At the same time the visual scene was really overturned (everything is upside down). So this method is called “double overturn”. The invertoscope was designed on the base of head-wearing binocular loupe and two Dove prisms. It provides the vertical inversion. The horizontal field of view was 40° 40'; vertical field of view was 22° 60'.

The stimulus was an artificial visual scene looking like a toy room with a table, cups and plates. The toy room was made of carton (size 24x52x31 cm), window and curtains were painted on the walls. All objects inside the room could be overturned for 180°.

To exclude other objects out of the participant’s field of view toy room was placed into a special construction 120x60x60 cm sized which was made of wooden beams and dark fabric and had a parallelepiped shape. Ophthalmic head-chin rest was used to fix the participant’s head.

2.3. Procedure.

The participants were not informed about the fact of inversion, they were told that the optical device is used to limit their field of view. To create a conflict situation (the conflict between sensory fabric and meaning) in perceived scene an experimenter used the following experimental manipulation:
The experimenter`s manipulations: (a) in fact; (b) observed by the participant wearing the invertoscope.

1) The bringing new visual information into the presented scene: the experimenter carries the teapot (with granulated sugar in it) in the overturned room and begins to pour the granulated sugar from teapot down (fig.1.1). As a participant looks at the visual scene through the invertoscope, she/he really sees that the experimenter is pouring granulated sugar to the ceiling (fig.1.2).

2) The including additional haptic information: each respondent is asked to put the teaspoon into the cup.

The type of additional information was the independent variable. The participants were asked to describe the perceived scenery. The participant`s awareness that the toy room is really overturned was dependent variable. The order of the presentation of additional information was varied with group of participants. For Group 1 the observation of the experimenter`s manipulation with granulated sugar was the first experimental probe and the attempt to put the spoon into the cup was the second one, for Group 2 it was vice-versa.

Fig.1. The experimenter`s manipulations: (a) in fact; (b) observed by the participant wearing the invertoscope.

The next step was the study of the role of personal sense in image formation with using the “double overturn” technique. Personal sense can be operationally defined as relation between the motive and the goal of human activity. So we have to utilize both these constructs and to link them to one component of presented visual scene (in our case – granulated sugar). For this purpose granulated sugar was included in the situation of problem-solving. The special task was presented to the participant as a variety of IQ test to provoke the examination motive. The participants were asked to resolve modified Lachin`s task (based on Lachin`s task [16]) - the problem solving task with pouring of the sugar. The participants perceived this situation like stressful and significant. At the same time the goal was to solve this concrete task. This goal could be achieved or not. Success or failure of resolving were regulated by experimenter who varied the time of task solving and its difficulty level. The presence of additional task and success of its resolving were independent variables.

After the problem-solving participants observed the scene where the experimenter carried the teapot into overturned room and began to pour granulated sugar from teapot down. The control group observed the scene at once without an additional task. The existence or absence of illusions (for example, perceived water or steam instead of sugar) were fixed. It was the dependable variable. All participants were divided into 3 groups: the control Group, the Group “Success”, the Group “Failure”.

The experience of the participant`s interaction with the granulated sugar in the problem-solving task could influence the appearance or absence of the illusion too. To avoid the influence of this feature we increased the time between the task and the presentation of the visual scene. For the same purpose the questionnaire "Imaginative sphere" (Gostev [17]) was used. The objective of the questionnaire was to imagine the different
patterns and estimate their vividness. This task switched the participant’s attention from solving problems with sugar to other visual images. The control of confounding variable was realized in the following ways: the equalization of the participant’s sample by gender and age, coping strategies (the questionnaire SACS of S. Hobfoll in adaptation by N. Vodopyanova and E. Starchenkova [18]), achievement motivation (A. Mehrabian’s questionnaire in adaptation by S. Shapkin [19]).

3. Results

To test the first hypothesis, 16 participants were asked to describe the presented visual scene. Only 5 people of 16 subjects mentioned the perceived visual scene as illusory. This feature was associated with a limited angle of view and the toy stimulus material. None of participants had the assumption that the room could be turned over. Thus, the participants do not notice the fact that the scenery is inverted if there is no conflict between the sensory fabric and the meaning of the perceptual image.

After experimental manipulations (additional visual or haptic information) all participants understood that the room was overturned. In Group 1 (where the participants started with the experimenter’s manipulations with granulated sugar) 6 participants of 8 understood that toy room was overturned. In the second Group (where the participants started with their own action to put the spoon into the cup) 7 participants of 8 reported on the overturned room. Therefore, the colliding sensory fabric with meaning are provided to encourage the subject to rethink the perceived scene. For this purpose, it’s equally successful to appeal both to the visual, and haptic modalities.

Some participants did not recognize granulated sugar itself (as such) and illusory saw other substances in the space of visual scene. It was found that the participants in Group 1 at the beginning of the observation often illusory perceived sugar as steam or water (6 of 8 subjects), while in group 2, which had the opportunity to interact manually with the toy room (at the first probe), the illusions were much less (3 of 8). Below there are some examples of such illusions:

"The steam comes out of the kettle" (participant A).
"At first it seemed that the steam comes out of a pot. I did not understand at once that it was sugar. I heard the sound "pshshsh" when sugar was pouring. In my opinion something boiled in the kettle" (pat. K.).
"Water is flowing upward. I can see the hand that is pouring to the ceiling. Traces are on the ceiling. What a pity! Now this room is in need of repair" (participant O.).
"And the water is flowing up to the ceiling" (participant Ya).
"There is all right, except the pile of sugar on the ceiling, but now it is very similar to the futuristic lamp." (participant V.).

The analysis of the self-reports led us to state new questions. It was the basis of the second part of study: is it possible to create special conditions that could influence the occurrence of such illusions? In this part of study the following hypothesis was tested: giving an additional personal meaning to one component of the presented scene (in our case – granulated sugar) has an impact on the illusionary transformation of the perceptual image in the conditions of inverted vision. The results indicated a difference in the number of participants who saw the illusions in the control group and the two groups with additional task (success/failure of the solution) (table 1). This difference in the appearance of illusions between the groups was statistically significant ($\chi^2 = 18,585$, $p<0.001$). It is specially stressed that only one person had illusion in the group “Success”.

The comparison of groups “Success” and “Failure” found out statistically a significant difference in the number of illusions too ($\chi^2 = 5,015$, $p=0.025$).

| Participants | The control group | The group “Success” | The group “Failure” |
|--------------|-------------------|---------------------|---------------------|
| The number of participants who | 13                | 1                   | 7                   |
4. Conclusion

1. If there is no conflict between the sensory fabric and the meaning of the perceptual image the observers did not notice the fact that the scenery was inverted.
2. To encourage the subject to rethink the space of the image, you need sensory fabric and meaning to collide. For this purpose, it's equally successful to appeal both to the visual, and haptic modalities.
3. Giving an additional personal meaning to one component of the presented scene has an impact on the illusory transformation of the perceptual image in the conditions of inverted vision.
4. The method of "double overturn" was designed. It allows us to study the structure of conscious image: sensory fabric, the meaning and personal sense.

References

[1] Companeysky B.N. The problem of perception constancy of form and color of things. Leningrad: Herzen Russian State pedagogical University, 1940. (In Russian).
[2] Logvinenko A.D. The visual perception of space. Moscow: Moscow State University, 1981. (In Russian).
[3] Logvinenko A.D. Psychology of perception. Moscow: Moscow State University, 1987. (In Russian).
[4] Martin T. A., Keating J. G., Goodkin H. P., Bastian A. J., Thach W. T. Throwing while looking through prisms. II. Specificity and storage of multiple gaze-throw calibrations. Brain 1996; 119, p.1199-1211.
[5] Zinchenko Yu.P., Menshikova G.Ya., Bayakovsky Yu.M., Chernorizov A.M., Voiskounsky A.E. Technologies of Virtual Reality in the Context of WorldWide and Russian Psychology: Methodology, Comparison with Traditional Methods, Achievements and Perspectives. Psychology in Russia: State of the Art v. 3, Lomonosov Moscow State University; Russian Psychological Society Moscow, 2010; p. 12-45.
[6] Stratton G. Some preliminary experiments in vision without inversion of the retinal image. Psychol. Rev. 1896; vol.3, 611- 617.
[7] Stratton G.M. Vision without inversion of the retinal image. Psychol. Rev. 1897: 4, p. 341 - 360.
[8] Sperry R.W. Effect of 180° rotation of the retinal field in visuomotor coordination. Journal of Experimental Zoology. 1943: vol. 92, no.3, p. 263-279.
[9] Snyder F., Pronko N. Vision with spatial inversion. Kansas: McCormick-Armstrong; 1952.
[10] Kohler I. Experiments with goggles. Sci. amer. 1962: vol. 205, p. 62-68.
[11] Kohler I. The formation and transformation of the visual word. Psychological issues. 1964: vol. 3, no. 4, monograph 12, p. 1-173
[12] Howard I.P. Perceptual learning and adaptation. Britain med.bull. 1971, vol.27, p. 248-252
[13] Harris C. S. Beware of the straight-ahead shift: a nonperceptual change in experiments on adaptation to displaced vision. Perception 1974, vol.3: p. 461-476.
[14] Yates M., Vicario C., Loetscher T., Nicholls M. Visuomotor adaptation to prismatic lenses influences numerical cognition. Perception, ECVP Abstract supplement. 2012, vol 41, p.136.
[15] Leontev A.N. Activity, Consciousness, and Personality. United States: Prentice-Hall; 1978.
[16] Luchins A.S., Luchins E.H. New experimental attempts at preventing mechanization in problem-solving. Journal of General Psychology, 1950; 42, 279-297.
[17] Gostev A.A. Imaginative sphere of human. Moscow: Institute of Psychology of Russian Academy of Science; 1992. (In Russian).
[18] Vodopyanova N.E., Starchenkova E.S. Strategies and models of coping behavior. In: Nikiforov G.S., Dmitrieva M.A., Snetkova V.M., editors. Practical training of the psychology of management and professional activities, St. Petersburg: Piter – Press; 2001, p. 311 - 329. (In Russian).
[19] Shapkin S.A. Achievement motivation questionnaire. *Psychological journal*. 2000: 2, p. 113-127. (In Russian).