Creativity, anticipation and the quantum theory of consciousness in cross-disciplinary studies: 3D perception of 2D images

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Abstract

In this article, the perception of 3D attributes (depth, volume and spatial perspective) is examined from the perspective of creativity, the anticipation phenomenon and the quantum theory of consciousness. The aim of the work is to consider activation of the incubation and insight processes under the influence of flat images in the modern visual environment. It is shown that not only can people perceive 3D objects as 3D objects but they can also perceive man-made 2D images as 3D objects. The main condition for the 3D phenomenon to occur is extensive visual training, which requires the trainee to look at stereograms and observe their stereoscopic depth. The results of interviews of 336 schoolchildren of 8-11 grades on the initial state of the 3D phenomenon - the relief effect are presented in this work. It is experimentally shown that when observing a phenomenon, new physiological features of perception are formed. Focusing of eyes occurs behind the plane of the presented images. This feature was detected using a binocular eyetracker.

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Keywords: three-dimensional perception, visual perception, binocular eyetracker, creativity, quantum theory of consciousness, consciousness

Introduction

Creativity is the characteristic that distinguishes the ancestor of the modern human from other hominids. In the XXI century another characteristic of human development seems to be emerging – transforming visual perception with the development of a new capacity to perceive three-dimensional attributes in two-dimensional images (the 3D phenomenon) (Antipov, 2018b).

In recent years a number of reviews of the literature about eye movements and processes of visual perception of a volumetric image have appeared (Schütz, Braun & Gegenfurtner, 2011; Kowler, 2011), showing that these issues continues to be a focus of active interest. Iijima, Komagata, Kiryu, Bando, & Hasegawa (2012) was studied the process of perceiving the depth on a flat screen when watching movies. Ringach, Hawken and Shapley (1996) showed that when moving a flat image, it is possible to perceive a three-dimensional structure, i.e. image depth. In our work, the phenomenon of formation of volumetric visual perception on flat images is investigated.

According to the Theory of Inventive Problem Solving, inventions of this type can form new types of engineering (Altshuller, Zlotin, Zusman & Filatov 1989). In other words, not only can people perceive 3D objects as 3D objects but they can also perceive man-made 2D images as 3D objects. In this article the perception of 3D attributes (depth, volume and aerial perspective) is examined from the perspective of creativity, the anticipation phenomenon (Mendelevich & Granica, 2014) and the quantum theory of consciousness (Penrose, 1989).

Objective reduction, the quantum theory of consciousness and the perception of 3D attributes

At the start, it is important to refer to the work of Popov (2015) in which he develops the ideas of Bekhterev that human beings are elements of the Universe just as any material thing. Therefore, all the laws that apply to nature equally apply to people (Bekhterev, 1994). It is noteworthy that the Bekhterev's concept of consciousness largely coincides with the data of modern cognitive psychologists who formulated the idea of nuclear knowledge systems (Kinzler & Spelke, 2007).

Penrose (1989) proposes a revolutionary idea that the quantum theory doesn't have the principal element that would explain the phenomenon of consciousness. In fundamental physical processes at the nanoscale level energy is conserved and the system "cannot forget" initial states. It is usually assumed that these processes, working in accordance with the parallelism principles, underlie cerebration.

Penrose believes that the phenomenon of consciousness is closely related to physical processes that happen on the quantum level, to so called objective reduction. The main idea here is that when a quantum system is not observed it still experiences 'reduction' – it manifests microscopic characteristics and out of multiple options choses one. If this kind of occurrence was discovered then the whole world view would change dramatically. This discovery would bridge physical and physiological ways of understanding the world.

Stereoscopic vision and binocular disparity occur when two slightly differently positioned projections of 3D objects appear on the retina of a pair of human eyes (two points of view). When the brain compares the two projections the person perceives the depth and volume of the objects. The visual system allows the person to accurately identify how objects are located in relation to each other. When the person looks at flat images (2D objects) then these images form identical projections and the brain immediately identifies them as what they are – 2D images. So, flat images are not supposed to convey the sense of depth, volume and aerial perspective (3D attributes).

Now consider what the ideas of Penrose and the 3D phenomenon have in common. As we demonstrated (Antipov, 2018a), human eyes are able to perceive (or able to learn to perceive) 3D attributes when looking at 2D images. We believe that the main condition for the 3D phenomenon to occur is extensive visual training which requires the trainee to look at stereograms and observe their stereoscopic depth. This training needs to occur in static as well as dynamic conditions. The stereogram in Figure 1 was used when the 3D phenomenon occurrence was recorded. The image in Figure 1 is a self-made second author of this article.

Figure 1. The stereogram used to record the 3D phenomenon occurrence for the first time

This stereogram was created through combining the periodic sets of two images – branches with leaves and stone wall pieces. In order to see the stereoscopic depth one needs to focus one's eyes behind the stereogram so that the elements of the two images overlapped (fusion). Then there will be 6 periodic sets of branches. At the same time if an additional object (say a pen or a pencil) is put on the surface of this stereogram then it will be possible to observe two projections of this object. If one's eyes are focused in front of the surface of this stereogram then the periodic sets of the stone wall pieces will come into the foreground.

In this particular case, the 3D phenomenon happens as a person perceives depth by seeing that the periodic sets for the wall and leaves do not overlap meaning that there are 5 sets of middle branches. Moreover, the depth between the sets is no smaller than the stereoscopic depth.

Stereogram production depends on the set shift (how much the sets are shifted in relation to each other). The procedure of set selection is usually performed using software that is very similar to Adobe Photoshop. Three eye orientation types can be differentiated: (1) focusing eyes on the stereogram surface; (2) focusing in front of the stereogram surface; (3) focusing eyes behind the stereogram surface. The production of stereograms involves testing all three eye orientations when the periodic sets are being located. Moreover, it is reasonable to shift from one orientation to another quickly (within 1-2 seconds). In other words eyes perform constant scanning of the focal point within a specific diapason. This process allows to observe (perceive) stereoscopic depth when eyes are both in static and dynamic states. A more detailed description of the stereogram

production process is provided in Antipov (2018b). Which gives further detail and sets out the circumstances when the 3D phenomenon is experienced.

The stereogram presented in Figure 2 was produced with monocular perspective and based on the Nailya Khamidullina painting. This stereogram was produced by combining three projections. If you focus your eyes behind the stereogram then you will see the stereoscopic depth of space.

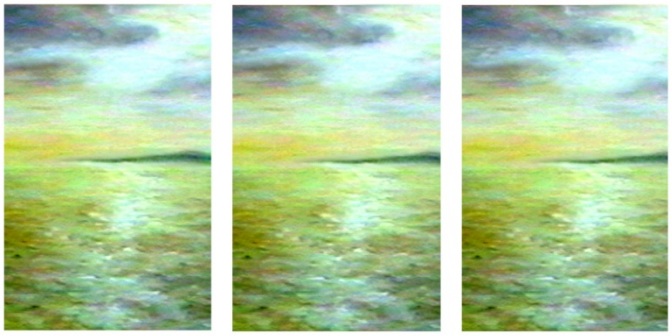

Figure 2. The stereogram produced by combining three projections

The upper cloud and water surface are in the foreground. The stretch of land on the right is in the background.

The described process allows people to develop new visual perspectives. It is reasonable to suppose that through training a new visual 'tool' is formed in the brain that prevents the brain from identifying these pictures as what 2D objects but sends the signal for these pictures to be perceived as 3D objects.

At the first stage of research, the subject was the second author of this article. Subsequently, surveys were conducted on various groups of respondents. It should be noted that consent was obtained from each study participant.

According to the theory of Penrose if the quantum system is not observed, it nevertheless can experience 'reduction' – it can manifest microscopic characteristics and out of multiple options choose one. One possibility is here to – the spatial perspective on one of the projections of the illustration provided in Figure 2.

In accordance with Penrose's ideas, the process of developing the 3D perception of 2D images in prospect can provide the empirical basis for studying the possibility of building the quantum theory of consciousness.

In addition, Penrose suggests that it is possible to name definitely at least one place where quantum phenomena play a role of principal importance for the human nervous activity – the nervous tunic of eyeballs that is in fact forms a part of the brain.

During the training process of assembling and observing stereograms, two slightly differently positioned projections get formed exactly on the nervous tunic of eyeballs. In our opinion this leads to the trainee experience the 3D phenomenon. At present, it is possible for the majority of 2D images that have aerial perspective to be perceived as 3D objects.

Creativity and 3D phenomenon

Caroff and Lubart (2012) assert that if a person has a creative potential then under the right conditions this person will certainly come to realize his/her potential (Meshkova, 2015). If we agree that the process of developing new visual and thinking abilities relate to the creative process then visual perception is capable of creating the necessary conditions for the development of creativity.

Let's consider the following definition of creativity: 'Traditionally in psychology there have been two main approaches to defining creativity: the first one is based on the products and results of creative activity and the other refers to the creative process. In accordance with the first

approach any activity can be viewed as a creative process if this activity leads to the creation of something subjectively or objectively new. In accordance with the second approach it is stressed that the creative process cannot be algorithmised; in essence it is the indivisible intertwinement of conscious and unconscious components' (our translation); the finding of a solution in this process is unexpected…' (Dikaya & Karpov, 2014).

Looking at the 3D phenomenon from the perspective of the first approach it is known that the natural mechanism of the visual perception does not allow to perceive flat 2D images with the characteristics of 3D space. The paintings that use monocular depth cues (developed by Leonardo da Vinci) create only an illusion of 3D space. Thus perceiving depth and volume (the 3D phenomenon attributes) when looking at a 2D image can be classified as something principally new. Moreover, we demonstrated empirically that observing the 3D phenomenon leads to physiological changes to human perception – the eyes begin to focus behind pilot images.

We discovered this with the use of a binocular eyetracker (Antipov, 2014). Pilot images were displayed on a computer monitor for a person to see. The binocular eyetracker, an instrument registering which trajectory a person's eyes follow when looking at a picture, measures X coordinates for the right eye *(Ra)* and the left eye *(Le)* (Figure 3). X coordinates are marked on the vertical line. Timing of the whole process is marked on the horizontal line. When the X coordinate for the right eye is the same as the X coordinate for the left eye *(i.e.* $X^{Le} = X^{Ra}$ *or* $\Delta X = X^{Le} - X^{Ra} = 0$*)*, person perceives what is on display as a flat picture (Figure 3-a).

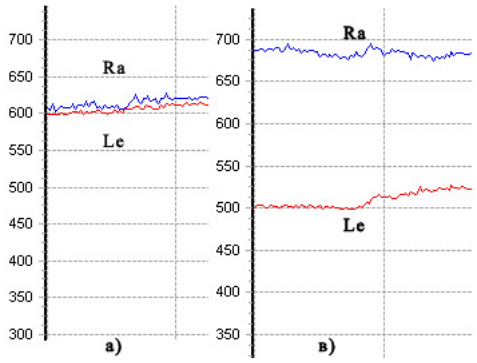

Figure 3. The reading of the eyetracker that registers how people perceive flat images (a) and how they perceive the 3D phenomenon (b)

This way when a person perceives a flat image X coordinates create two horizontal lines that are so close to each other they are merging into one (Figure 3-a). Our research showed that when a person perceives the depth and volume of the pilot images (the 3D phenomenon) then the two lines for the right eye and left eye start diverging ($\Delta X \neq 0$) (Figure 3-в). This data was obtained in two laboratories: The Center of Experimental Psychology (Moscow Psycho-pedagogical University) and The Laboratory of Visual Physiology (Pavlov Physiology Institute) (Antipov et al., 2012). Those pilot images that were used in the laboratories to identify when $\Delta X \neq 0$ were later used as 'reference' images in the course of our surveys aimed at identifying people who could perceive relief. Being able to perceive relief is the basic condition for developing the ability to perceive the attributes of the 3D phenomenon.

The second approach implies that the attributes of the 3D phenomenon are formed in the process of static and dynamic training in observing stereoscopic depth of stereograms (Fazlyyyakhmatov, 2018). This process of training can be viewed as a learning system consisting of five stages. People go through this process consciously but each stage in this process except for the first, gets initiated unconsciously by observing special training materials (stereograms), later leading the trainee to perceive all 2D images as having 3D attributes.

Within our project, we found evidence to defend our position that the perception of the 3D phenomenon relates to creativity – those who indicated that they could perceive the 3D effect when

looking at the pilot images (stereograms and other images used in our experiments) were more likely to be creative. Nine versions of stereograms were presented to comprehensive schoolchildren (8-11 grades, in total 336 students participated) in Kazan (Russia).

Within the course of our experiment along with nine pilot images, schoolchildren were given nine questions (tasks). Each 'Yes' reply scored 1 point and each 'No' reply scored 0. The maximum score was 9 points. The first task involved perceiving relief on a world physical map. Then we used our pilot images (that were used earlier in our eye tracking experiments) (Antipov & Zhegallo, 2014). We can reasonably argue that the 3D attributes of schoolchildren's perception were correctly identified. We also selected and prepared for demonstration flat raster 3D images. The effect of monocular parallax with the effects of depth was tested with the use of a video made with the camera moving along a flat surface of the stone surface image (Figure 4). Image was self-made second author of this article.

Figure 4. The image of stone surface

Schoolchildren were shown the fragment of the painting "Number 1, 1950 (Lavender Mist)" by Jackson Pollock (http://www.ibiblio.org/wm/paint/auth/pollock/lavender-mist/pollock.lavender-mist.jpg). Schoolchildren's replies revealed if they had an ability to perceive the depth of color palette. First, in order to test this ability schoolchildren were asked a question regarding depth and then questions regarding other effects. In the end, children were asked to move their head horizontally and report if they saw any changes in their perception. After this children were asked three questions regarding the image of stone surface and ultimately were tested (with an eye-tracker) if their eyes could focus at different depths when looking at this flat image and identify if there is a phenomenon similar to monocular parallax with the effect of relief.

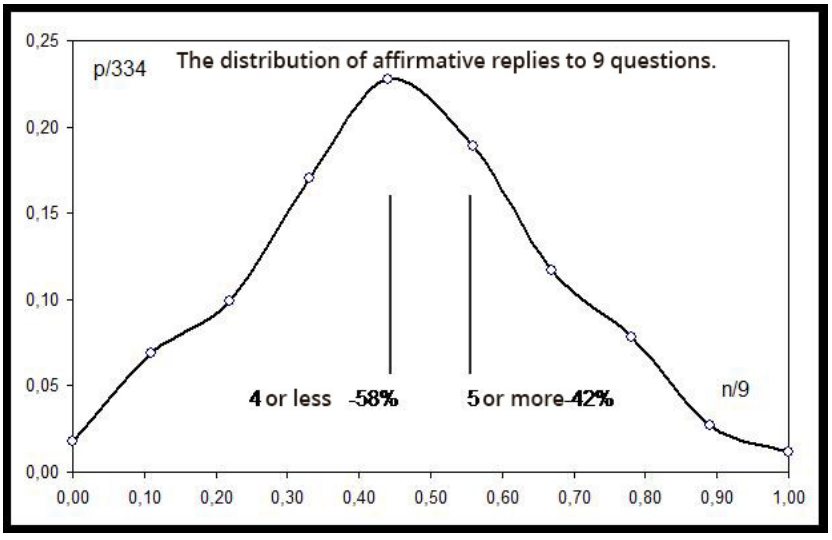

Figure 5. The distribution of relative values for children's replies

Figure 5 shows statistical distribution of schoolchildren's replies. The vertical line reflects the percentage of children who gave a positive reply to each question. The horizontal line reflects relative values of the replies (children's scores). As can be seen from Figure 5 the maximum value on the vertical line about 0.23. The left side of the graph shows that six respondents scored 0 on all of the questions; the right side shows that five respondents scored 1 on all of the questions and ultimately got the highest possible score. Moreover, 42% of the respondents said 'yes' to five or more questions. Overall, the majority of all respondents reported that they are familiar with the effect of relief. Some of them demonstrated that they have no problem with perceiving relief when looking at flat images.

If we suppose that the ability to perceive the 3D attributes in a flat image is an indication of creativity then it is reasonable to test the basic conditions for the development of the 3D phenomenon (i.e. to test a person's ability to perceive relief). The number of participants who could perceive the 3D effect in 8-9 stereograms was 57 (out of 336 students) (in order to monitor students' perception we additionally used a binocular eye tracker). These 57 students were then tested using the Torrance Tests of Creative Thinking and 80% of them demonstrated high levels of creativity: 50% of them demonstrated 'exceptional level', 30% – 'high level', 17.5% – 'higher than the norm' and 2.5% – 'the norm' (Ovchinnikova, Antipov, Baklashova & Afanaseva, 2016).

Anticipation and the 3D phenomenon

In order to consider carefully how the 3D phenomenon relates to anticipation we first need to look at the following two definitions. Mendelevich and Granica (2014) defines anticipation in the field of contemporary psychology as a human ability to anticipate events and actions and to adjust one's behavior based on reasonable predictions.

Concerning anticipation Evin (2003) writes: 'Studying the physiology of human and other higher animal behavior led many scientists to the conclusion that any purposeful action is preceded by the formation in the mind of a person of at least some kind of model of the expected action outcomes. Life evolution going from simple biological forms to higher social organization at some point led to the development of the ability to predict: since that moment people's predicting power has been increasing and the scope of predications expanding. Anticipation manifests itself in different human activities: at work, in sports, in everyday situations, etc. According to Anokhin any living organism in order to ensure its survival in a certain situation has to be able to prepare for this situation in advance if it represents a life threat'.

Examining with the second definition, let us consider how the 3D phenomenon relates to anticipation. The following sequence can be noted: action model formation ➔ action ➔ action outcome. Within our project 1500 young people (age 14-22) participated in our survey and the overwhelming majority of them indicated that they could see the relief (topography) of the physical map of the world and other 2D images. Figure 6 shows the diagram of relief perception for the group of 254 students in grades 7-11.

It is reasonable to suppose that a person's ability to perceive relief of the physical world map can be developed which could ultimately lead to significant changes in the visual system of a person. The visual system changes under the influence of an altered visual environment over the period of 15-20 years. Indeed, over the last 15-20 years we witnessed serious changes in our surroundings as computer technologies have been rapidly developing. The ability to perceive relief of the physical map does not constitute the ability to perceive the 3D phenomenon in most flat images – it is developed gradually as a psychological analogue.

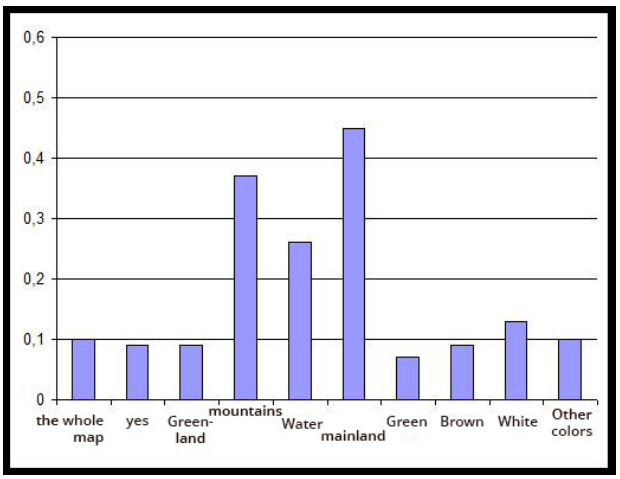

Figure 6. The diagram of the relief perception of the physical map of the world

Upon completing our one semester training course students developed an ability to perceive the basic features of the 3D phenomenon – they started seeing the 3D effects when looking at variety of 2D images (Figure 6).

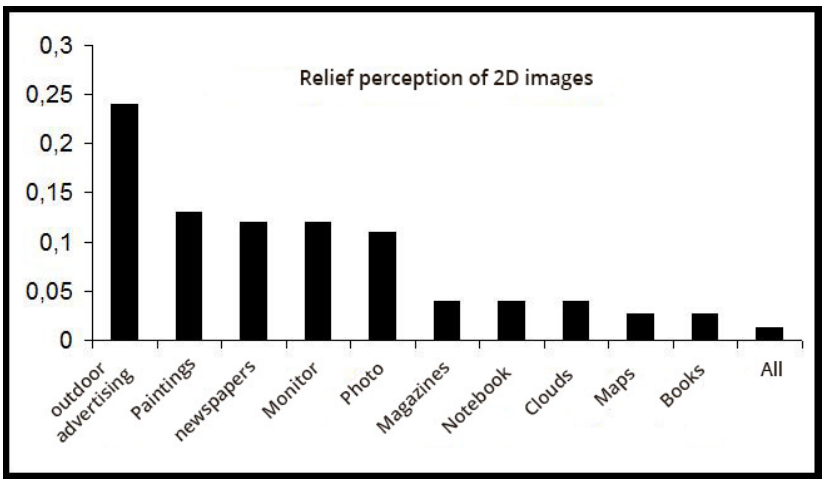

Figure 7. The diagram of the relief perception of other 2D images

It has to be noted that 1.5% of those who participated in our research were able to perceive the relief of all 2D images (the diagram from Figure 4). Around 10% of schoolchildren see relief of the whole map (Figure 7).

We predict that through observing relief it is possible to build a new model of developing the ability to perceive the 3D phenomenon fully (our model is described in detail in Minzaripov, Antipov, Shaposhnikov, Baltina, Skobelcyna & Yakushev 2009). Suffice it to say here that those who can see relief are more prone to creative development. However, the system of creativity development through visual perception that we designed can be used for and by any person. Moreover, the new visual environment is already upon us influencing our perception and thinking.

Conclusion

Let's consider different levels of evolutionary changes in behavior. They begin with a few individuals within one species learning a certain behavior pattern that gradually becomes a habit that can be performed automatically. Then this pattern spreads throughout the population and eventually becomes a hereditary feature of this species.

Now let us suppose that perceiving the 3D attributes can be viewed as a learned behavior pattern (Antipov & Zhegallo 2013). Our previous studies demonstrated that certain individuals can

already perceive the 3D attributes automatically. We surveyed around 1500 people and 90% reported that they know the relief effect as the first stage of the 3D phenomenon. Moreover, the same percentage of respondents (90%) reported that they perceive the relief effect automatically. It is reasonable to suppose that the different stages of the 3D phenomenon can be viewed as insight. Indeed, when the 3D attributes are perceived from 2D images it happens for a person suddenly without him/her realizing how or why.

It is impossible to say which newly developed abilities of human brain, which learned behavior patterns are here to stay, and will become hereditary. However, if insight is among them then we should soon witness the new stages of human evolutionary development.

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