Problem № 3
«Annoying foreground object»

Team «12FM»

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The task

Look at a flat photograph. What methods allow you to tell which objects were closer and which were farther from the camera when the shot was taken? Design and create a photograph that violates the intuitive judgment of relative distances.

Hypothesis

If a person perceives reality in three-dimensional space, so, when he examines a photograph, he can make a mistake in determining the distances between the objects and their dimensions.

Aim of the study

To create a photograph that disrupts the intuitive perception of distances.

Objectives

1. Study the literature;
2. Study monocular signs of perception of objects;
3. Create a photograph that can deceive the intuitive perceptions of a person, based on a violation of the signs of monocular vision;
4. Based on the principle of similarity, calculate the location of objects to create a picture of the illusion of a linear perspective;
5. Conduct a sociological survey on the perception of created illusions.

Theory

- **Monocular vision** - the ability to perceive objects with one eye.
- **Binocular vision** - the ability to see simultaneously and clearly the image of an object with both eyes, so a three-dimensional image is created.
- **Linear perspective** - a geometric way of constructing spatial objects on a surface using straight lines.
- **Optical illusion (also called a visual illusion) -** illusion caused by the visual system and characterized by a visual percept that appears to differ from reality.

Theory

Monocular features:

•Difference in the similar size objects. If you see that the size of one object is larger than the size of the second similar object, you conclude that the first object is closer.

•Overlaying of objects. If the part of an object is not visible because of the overlaying object, then the last object is closer.

Theory

Monocular features:

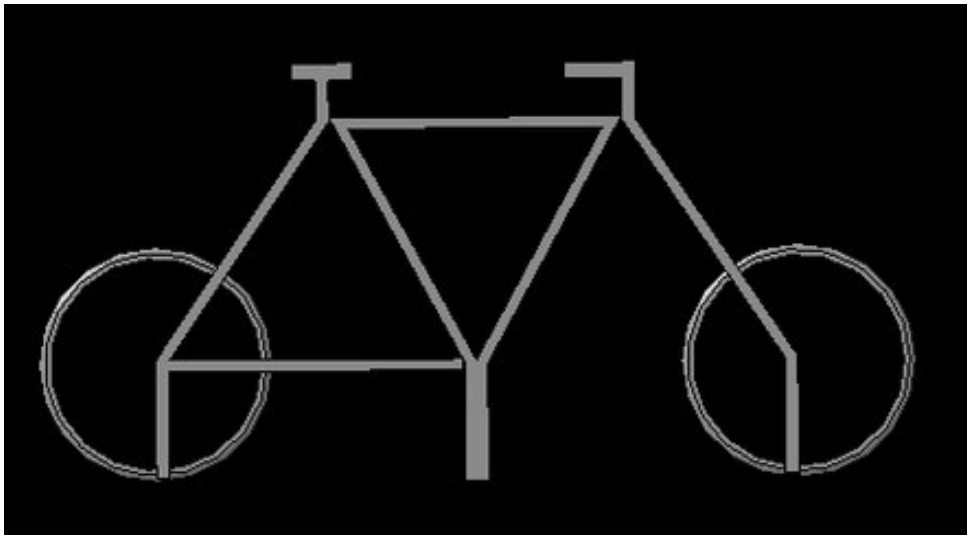
•Sharpness of the image. The farther the object, the less visible it is. This can be explained by the fact that the light from a farther object has to pass a greater distance.

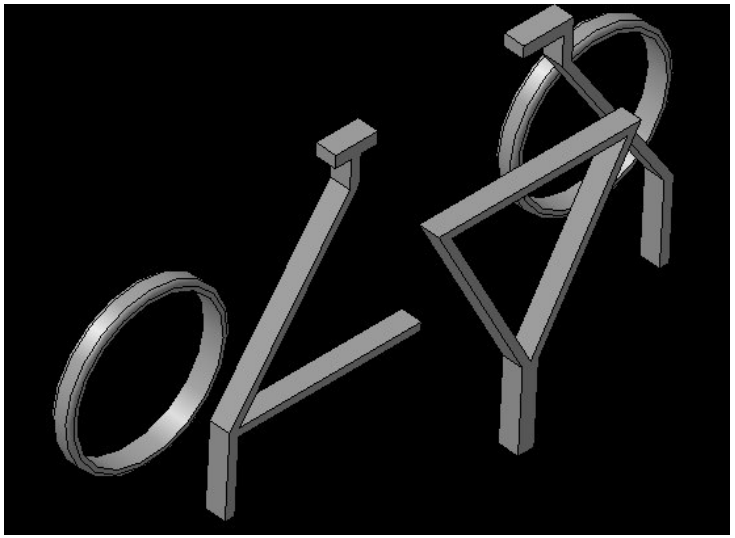
•Perspective**.** Perspective is a technique for depicting objects on the surface in accordance with apparent changes in their dimensions, by these dimensions you can determine the location of objects on a flat photograph.

Theory

Monocular features :

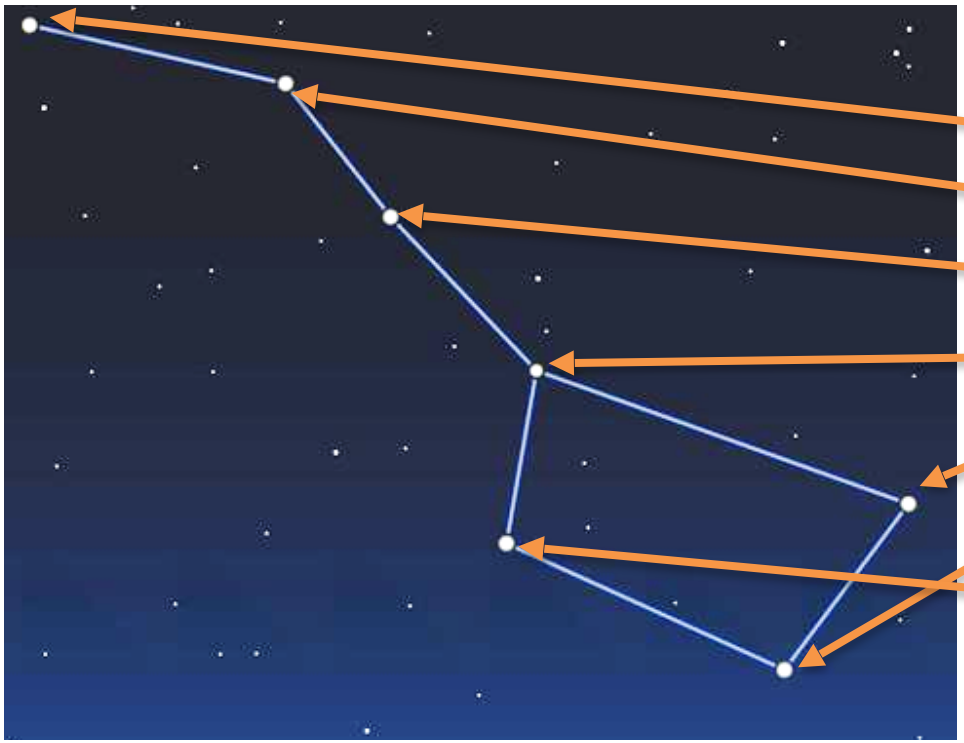
•View angle of illusion. This is the angle at which you can see the illusion.





Theory

Big Dipper from the constellation Ursa Major.

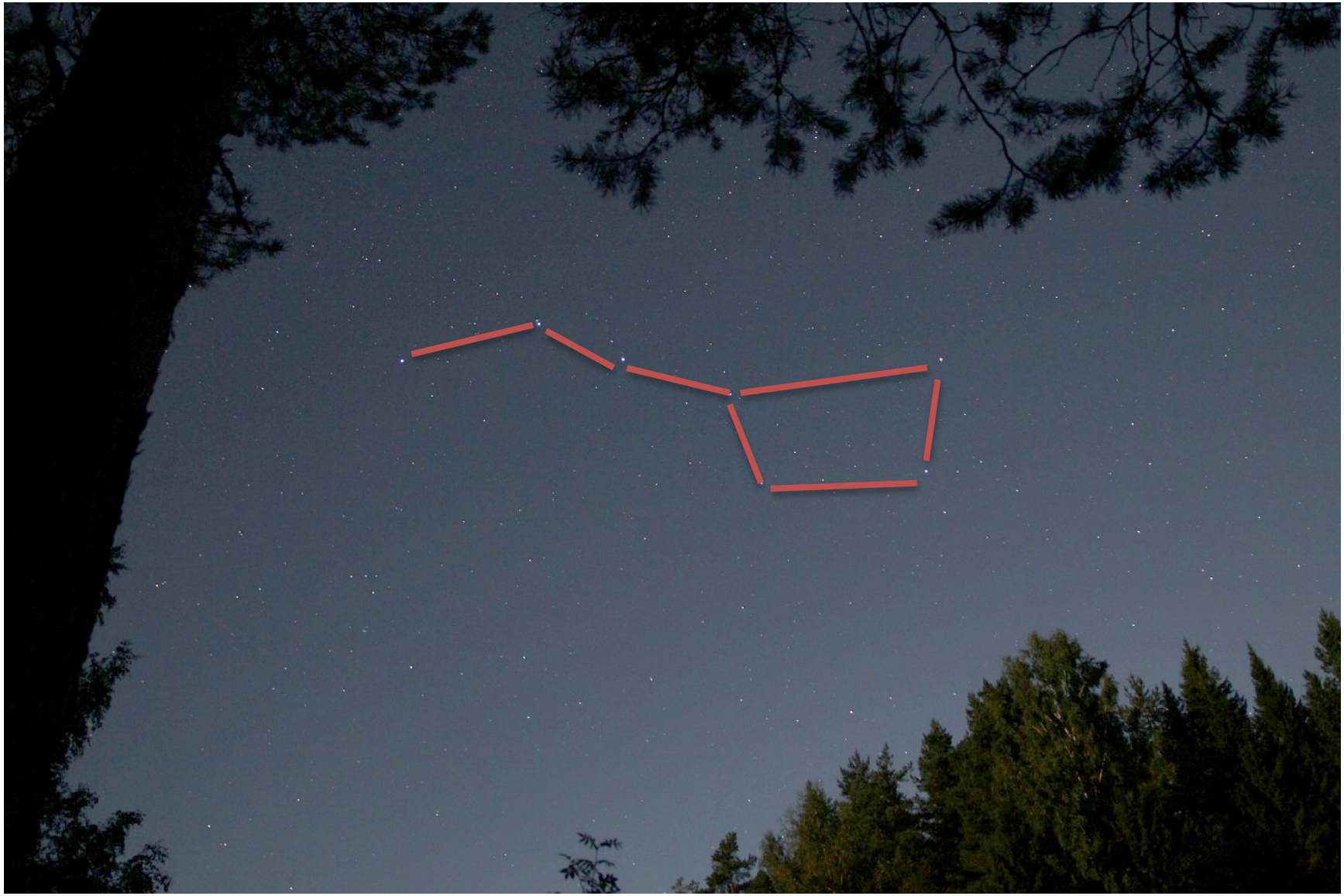


Distance from Earth to:

- star Alkaid - 101 light-year
- star Mizar - 78 light-year
- star Alioth - 81 light-year
- star Megrez - 81 light-year
- star Dubhe - 124 light-year
- star Merak - 80 light-year
- star Phecda - 84 light-year

So, the distance between the nearest star (Mizar) and the farthest (Dubhe) is 46 light years.

Theory



Experiment 1

Purpose: determine whether the triangles are similar, when we overlook at the top of the books.

Equipment: 2 rectangular books with a similarity coefficient k = 0.65; a camera; a ruler.

Side view

View from above

Experiment 1

Similar triangles - triangles whose angles are equal, and the corresponding sides are proportional. The ratio of the respective parties is equal to the similarity coefficient.

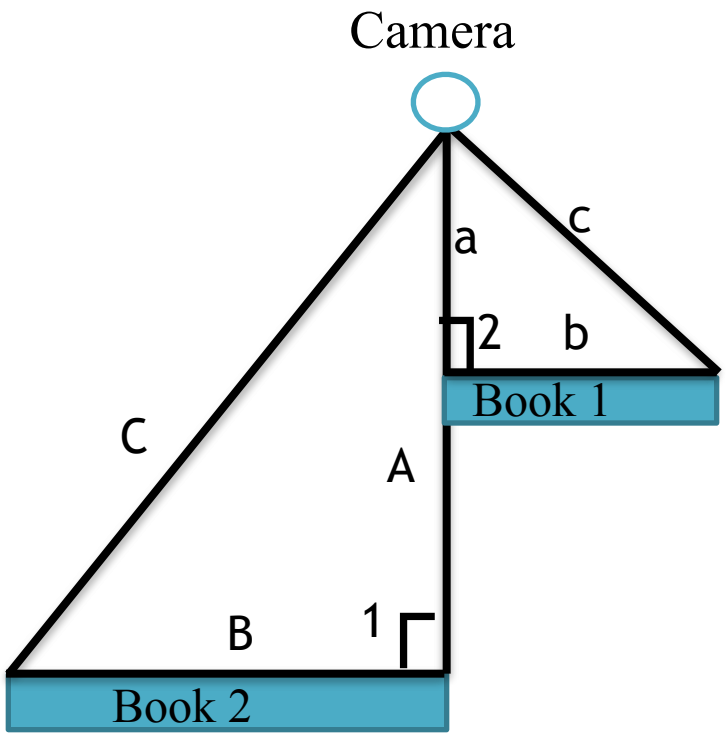
$$\frac{a}{A} = \frac{b}{B} = \frac{c}{C} = k$$

	The length, cm	The width, cm	Distance from camera to book, cm
Book 1	12	8,5	37
Book 2	18,5	13	57

Consider the triangles **ABC** and **abc**:

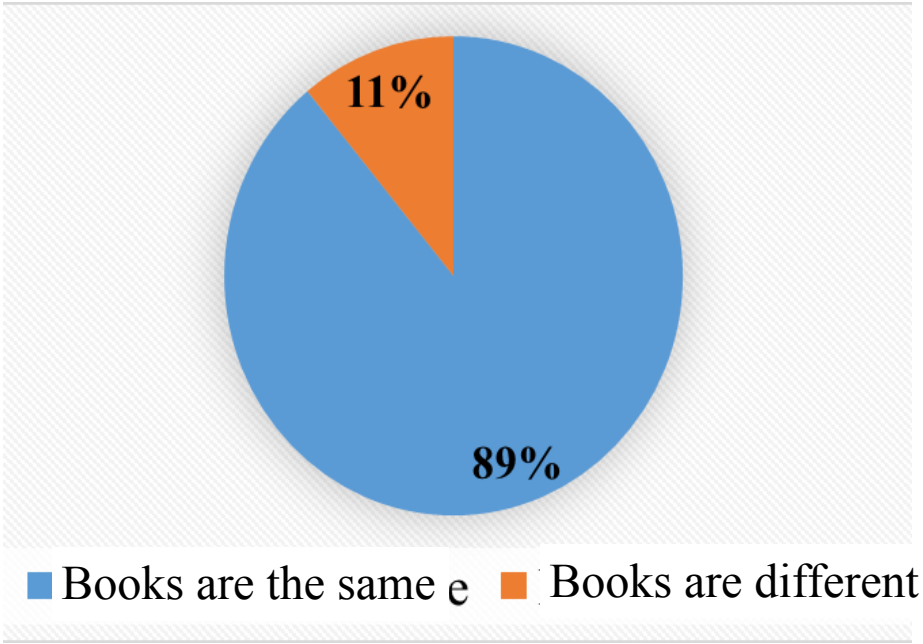
- **a** = 37 cm, **A** = 57 cm, **b** = 12 cm, **B** = 18.5.
- $\frac{a}{A} = \frac{b}{B} = 0.65 = k$
- angles 1 and 2 are equal to 90.

Therefore, triangles are similar (if two sides of one triangle are proportional to two sides of another triangle, and the angles between these sides are equal, then such triangles are similar).



Experiment 1

Books participating in the experiment have the same color and the same aspect ratio.



We have conducted a survey among 100 people and found that 89% of respondents said that books were the same size.

Conclusion: formed triangles are similar. Therefore, knowing the distance from the camera to the far book and the size of the book, you can calculate the location of the near book to create the illusion of a linear perspective.

Experiment 2

Purpose: verify the accuracy of using the similarity feature to create an illusion.

Equipment: 2 rectangular books; camera; ruler.

	The length, cm	The width, cm	Distance from camera to book, cm
Book 1	12	8,5	x
Book 2	24	17	57

$$k = \frac{12}{24} = \frac{8,5}{17} = 0.5$$

$$\frac{x}{57} = 0,5.$$

x = 28,5 cm

Experiment 2

Side view

View from above

Conclusion: when we look at a photo, it seems that the objects are the same size.
According to the survey among 100 respondents, 91% said that the sizes of these books were equal.

Experiment 3

Purpose: create a photo on which the perception of the sizes of books will be broken because of violation of a feature of sharpness of the image.

Equipment: 2 rectangular books; camera; ruler.

	The length, cm	The width, cm	Distance from camera to book, cm
White book	15	12	x
Yellow book	20	16	40

The similarity coefficient of the triangles is k = 15/20 = 12/16 = 0,75, therefore x =30 cm.

We put the white book at a distance of 30 cm from the camera and took a picture.

Experiment 3

Side view

View from above

Conclusion: we created a photo with an illusion. During survey it was found out that **74% of the interviewees thought that the yellow book was closer**. This can be explained by the fact that the yellow book is brighter and does not merge with the background, unlike the white one.

Experiment 4

Purpose: create a photo with an illusion by using the view angle.
Equipment: program "Compass - 3D", 3D printer, camera, glue, wooden base.

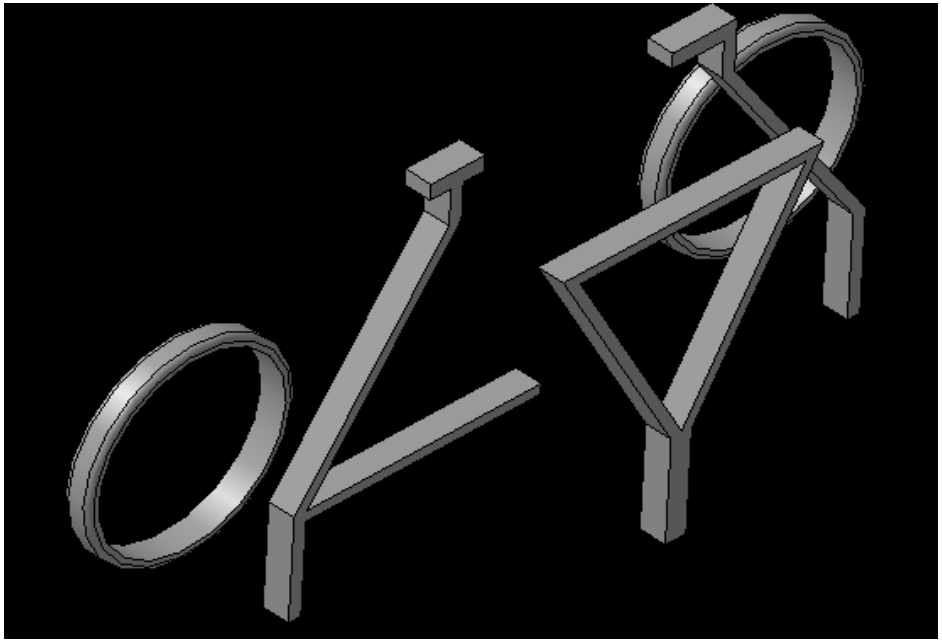
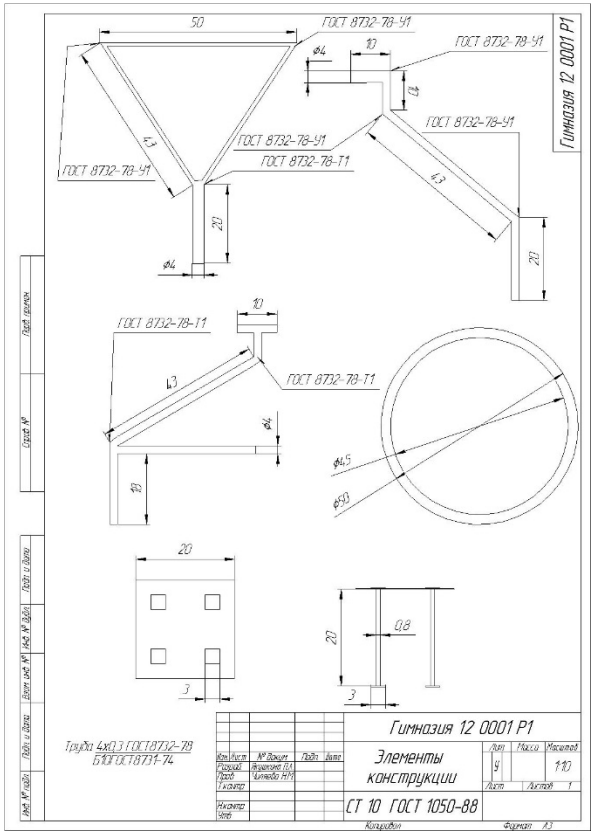


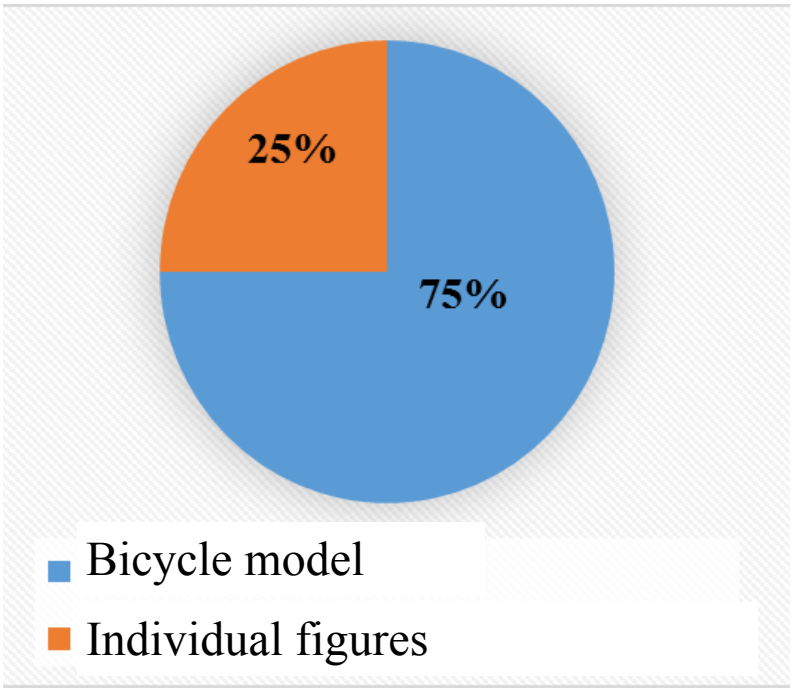
Image of parts when viewed at an angle



Technical condition

Experiment 4

Reconstructed illusion



During the survey, we found out that 75% of the respondents believed that the picture shows a bicycle model.

Conclusion: if you take into account the shooting angle and the apparent dimensions of individual parts when creating an illusion, you can achieve spatial distortion in perception.

Conclusion:

1. We created photographs that violate the person intuitive perception of the distances between the depicted objects and their sizes. It can be concluded that the angle of view, the size of objects and the sharpness of an image affect the person perception.
2. We have confirmed in practice that we can use triangles similarity to create illusions.
3. Based on the results of the survey, we concluded: most interviewed people had wrong perception of objects in the photos.

References

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