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The peculiarities of the spatial thinking in visually impaired children

The spatial thinking takes place in problem solving requiring orientation in practical and theoretical space (both perceived, and imaginary). It represents thinking by spatial images, in which the spatial features of the real object are fixed, as follows: the shape, magnitude, spatial relations between component parts of the object, its spatial position about any reference point. Operating the initial images created on a different demonstrative basis, the spatial thinking ensures their gradual modification, transformation and creation of new images distinct from initial. In opinion of the Russian psychologist I.S. Yakimanskaya, the spatial thinking is a kind of mental activity, which includes processes of creation of spatial images and operation by them.

The spatial thinking is exhibited as essential element of playing, educational, labour activity of the child, i.e. there, where it is necessary to use skills to be orientated in space. Therefore the spatial thinking development has very important correctional value for visually impaired schoolchildren: having seized receptions both modes of creation and operation by spatial images, the children gains skills permitting to them to perfect practice orientation and mobility in space, to improve the quality studies of school subjects, firstly mathematics, arts, geography, drawing etc. All this will promote the many-sided development of the schoolchildren and their successful social adaptation.

The initial perception by the person of the spatial features of the real object, which in its collections constitute the spatial image, happens in main with the help of vision. In this connection naturally to suspect, that the development of processes of creation of spatial images and operations by them in conditions of visual impairment has particular originalities in contrast with conditions of normal vision.

The process of operation by spatial images plays the main role at development level definition of the spatial thinking. The level of spatial thinking development is characterised by ability to fulfil operation by spatial images according to the particular type.

There are three types of operation by spatial images. The first type is a change of spatial image position only. The second type is change of spatial image structure only, and the third type is the combined change of both spatial position of the image and its structure. A sequence of becoming of ability to fulfil operation by spatial images for the particular type is compounded with stages and levels of development of spatial thinking.

Methods of the research

We conducted comparative research of spatial thinking of normally sighted and visually impaired schoolchildren. Methods of research consisted of three series of the tasks requiring operation of different types by spatial images.

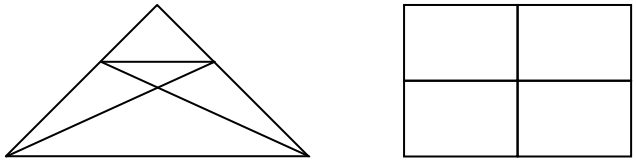

Fig. 1.

In the first series of the tasks the operation by spatial images was required according to the first type: it was necessary to select all triangles and rectangles on a delineation (Fig. 1), for this purpose it was necessary to change a reference point so that the demanded figure became is clear visible.

The second series of the tasks required operation by spatial images according to the second type: it was necessary to construct new figures (rectangle, rhomb, triangle) from four equal rectangular triangles. Children should mentally constitute new figures and draw them (Fig. 2).

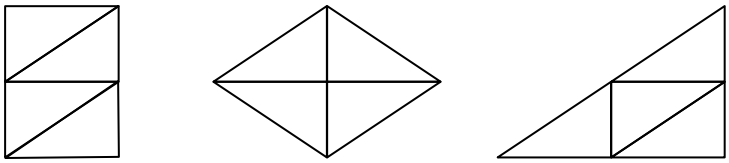

Fig. 2.

The third series of the tasks required operation by spatial images according to the third type. In the first task of this series it was necessary to fulfil imaginary transformation of figure with the help of rotational displacement. In the second task of this series it was necessary to fulfil a drawing of a figure on the basis of delineation of its half (Fig. 3). The task can have three solutions, each of which one is gained with the help of transformations of axial symmetry concerning legs of the given detail.

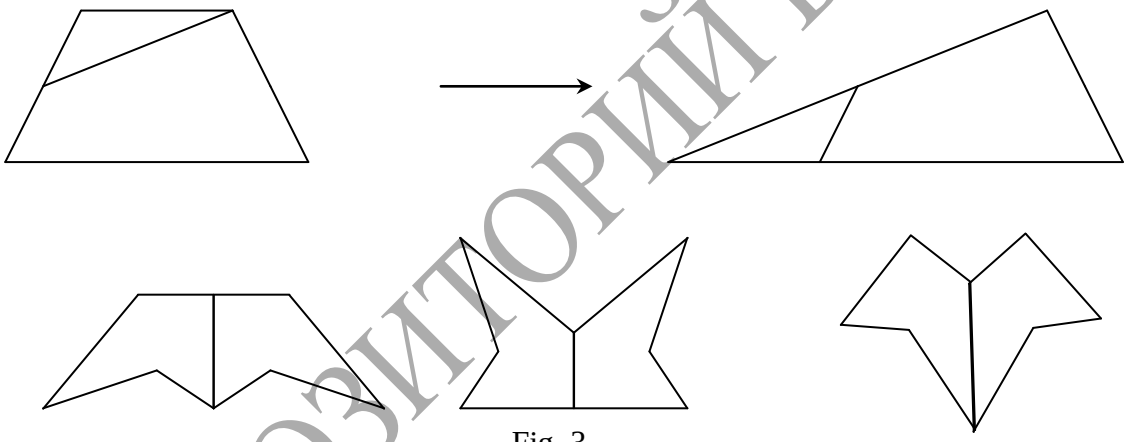

Fig. 3.

In a case, when pupil didn't manage task execution by mental manipulation, he was offered to fulfil the task practically with the help of figures cut from cardboard.

Description of samples

The samples consist of 62 schoolchildren of the last grade level in primary school (age 10-11 of years): 30 normally sighted pupils and 32 visually impaired ones without multiple disabilities. The diagnoses of visual diseases: different types of refraction disturbances, retinopathy, pathology of optic nerve, function disturbances of oculomotor means. The visual acuity with correction in visually impaired schoolchildren didn't exceed 0.2.

Results and their analysis

The data of the table 1 testify to lag of visually impaired children from normally sighted peers: there were children among them, which could not select any figure. At the same time a lot normally sighted children is significant, which have selected all figures. The selection of triangles was more difficult, than selection of rectangles, including for normally sighted children. That it is possible to explain by more complex course of choice of reference point (delineation of rectangle consists of horizontals and verticals only).

Table 1. The figure selection

	haven't select any figure	have selected figures partially	have selected all figures
NS	-	76.7%	23.3%
VI	15.6%	75.0%	9.4%

It is necessary to mark, that many normally sighted pupils, fulfilling this task, turned delineation so that one of legs of the figure, selected in the given moment, placed horizontally concerning pupil, thereby, they changed reference point. The figure is visible in the comfortable configuration for the child at choice of such reference point. Any visually impaired child didn't use such reception at perception of delineation. It testifies to the development of projective substructure of spatial thinking lags behind in conditions of visual impairment. This substructure provides vision of figures from any point of view.

However, it is possible to mark some operations, identical to both groups: children named already isolated figures, drew of an outline of these figures by the forefinger in air; indicated of intermediate points at a label of composite triangles. This operations can be estimated as peculiar visual legs.

The data of the table 2 testify to lag of visually impaired children from normally sighted peers at performance of operation by spatial images according to the second type: 70 % normally sighted and only 25 % visually impaired pupils have fulfilled the tasks by way of mental operations. Greatly more pupils with visual impairment, which have not fulfilled the tasks even practically: 25% against 6,7%.

Table 2. The figure construction

	haven't fulfilled tasks	have fulfilled tasks practically	have fulfilled tasks mentally
NS	6.7%	23.3%	70.0%
VI	25.0%	50.0%	25.0%

Majority of pupils developed demanded figures sequentially: having drawn one triangle, children added to it second and so on. Such "synthetic" mode of performance was present as at construction of figures with simple structure (rectangle, rhomb), and at build-up of triangle. It testifies to that the rigorous imaginary image of constructed figure isn't formed immediately for samples, and they need peculiar visual leg by the way sequentially of fulfilled drawing.

Though some children, in main normally sighted, have used other, "analytical" mode of build-up: for example, having drawn rectangle, conducted median perpendicular in it and in the formed smaller rectangles conducted diagonals ; drew rhomb and then conducted diagonals in it. There was dominance of the first mode of task execution. It can testify about characteristic for this age combination of visual - practical and only mental operations in thinking.

The data of the table 3 testify to low level of mastering of operation of the third type by both groups: a great many of children from both groups haven't fulfilled the tasks even practically, and majority all pupils don't come on a level of performance of spatial transformations by way of mental operations. In too time it is impossible to speak that such type of transformations isn't accessible to children of the given age.

Table 3. The figure transformation

	haven't fulfilled tasks	have fulfilled tasks practically	have fulfilled tasks mentally
NS	33.3%	53.4%	13.3%
VI	59.4%	34.4%	6.2%

The principal singularity, characteristic for the majority pupils, was longing to fulfil rotational displacement of a triangle around of a certain point being centre of this triangle, instead of around of point - top. It can be explained by a stereotype of practical representations and practical experience of children, in which often children fulfil rotational displacement around of themselves, i.e. use own bodies as the reference system ("from itself" the reference system).

At performance of the last task the majority of pupils in both groups admitted an error, surveying transformation of axial symmetry concerning direct, resembling through two lower tops. These pupils did not feel that the figure can not exist practically which has been carried out on such delineation,. Such error was not marked for children fulfilled the representation by way of mental manipulations, they at once defined amount of optional versions. The most complex was the axial symmetry concerning a sloping leg of a polygon.

The data testify, that the primary schoolchildren weakly possess required transformation, though a level of possession of axial symmetry slightly higher, than level of possession of rotational displacement. Such singularity is explained to that rotational displacement more complex transformation, as from the standpoint of mathematics, and psychology: the rotational displacement is produced not on straight line with use the linear measure, but on arc of a circle with application of angular measure.

Outputs

1. The low level of operation by spatial images is characteristic for the majority of the primary schoolchildren: the operation for the first type and to a less degree for the second type is accessible to them. The operation by spatial images for the third type is not accessible practically to children of this age.

2. Idiosyncrasy of operation of the schoolchildren with visual impairment is the static character of generated images, rigid affection them to any one reference point. As a rule, the transformations are fulfilled chaotically, inconsistently, there is not schedule of interior operations, there is no prescience of total image of transformation.

3. There is a legible tendency testifying to lag of the spatial thinking development in conditions of visual impairment, and this lag is statistically significant at operations for the first and second types.

Conclusion

The structure of the spatial thinking coincides with the structure of geometric transformations group, i.e. maps of space to itself of different character such, as axial and central symmetry, rotational displacement, parallel transposition, homothety etc. This position is proved by the Russian psychologist I.Ya. Kaplunovich. And so ability of the child to operate with spatial images for the particular type is compounded with its ability to fulfil an appropriate set of geometrical transformations.

On our view, the pedagogical system on development of spatial thinking of the schoolchildren with visual impairment should be grounded on learning of children to geometrical transformations, as in two-dimensional, and three-dimensional space. Now in a content of mathematics course of primary school in our country not enough attention is given to geometrical transformations learning. Therefore it is necessary such modification in content of learning of the schoolchildren. During

such learning the child can seize skills of creation of spatial images and operation by them during solving of the manifold practical problems requiring of activity in space.

Integral part of offered modifications is the creation of special training tools so-called dynamic models of geometrical transformations. These training tools should ensure a possibility of demonstrating of all phases of performance of geometrical transformation to the child with visual impairment, i.e. not only initial and end position of conversed geometrical object, but also all of its intermediate positions. Such equipment will provide reliable acquisition of properties of geometrical transformations and algorithms of their performance with the child.

During creation of spatial images and operation by them the main role belongs to thinking, representation, imagination etc. Thus, the pedagogical system on development of spatial thinking built with allowance for of mentioned above factors, will allow to perfect the process of mastering by the visually impaired children of primary school age by manifold aspects of activity grounded on spatial thinking, and, as a whole to stimulate their cognitive development at the expense of integration of representation, thinking and imagination. All this will promote many-sided development of the pupils and their successful social adaptation and integration in society.