

# Topological Consideration about the Center in Drawings by Children

Motoya, Yoshiko

**Abstract**— *The concept "center" plays one of the most important roles in the thinking and behavior by children. In their drawings, children find difficulties in representing a center or a centralization-expansion. In the cognition of space by children, the structure and logic of center relates to the more complicated problems of core and circuit, axis and rotation, pairs and alternation and so on. We have analyzed and examined the drawings of a model, and tried to compare it with their physical movement (dance).*

**Keywords**— geometry topology domain drawing center core axis rotation

two figures are drawn in different directions, they cannot centralize to one central point, even if the two domains (the inside and the outside) come in contact with each other. In order that lines may centralize to one point, the axes of figures must be directed to it.

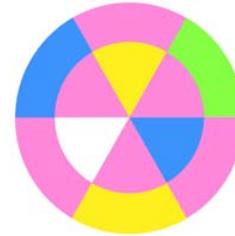


Figure 1: Model

## Introduction

Children from 3 to 5 year old are told to draw a model (fig. 1). The model is devised for children to think about the inside and outside, pairs, connections, direction of figures, exceptional cases, and through these to find the various meanings of the concept of center. Children 4 year old, played a dance (Japanese YOSAKOI dance) after the first drawing, and then drew it again. We examined what kind of improvement they showed in the drawing after the movement, and to what extent was the effect in their cognition certified. To draw the center correctly, children must understand the opposites, such as center and circumference, pairs and alternation, axis and rotation and so on. Children will be expected to make progress in the understanding of center by way of the physical praxis and the intercourse between others.

## The cognition of center

[Grph.1] shows how and to what extent children can draw the center as a point. 5 year old children understand the meaning of center and can draw it clearly, though many 4 year old children find difficulties.

When children draw a picture without any suggestions, they draw it in many different ways, for example with one color, with two or more colors separately, by the opened contour lines and so on. [Grph 2] shows the relation between two colors from the standpoint of the connection of the inside and the outside. In the drawings by 4 year old children, compared with that of 5 year old children, two colors do not successfully conform to each other. When

2005.5.11	N	pretest	posttest	total
		sheets	sheets	
3 year old children	5	5		5
4 year old children	21	32	31	63
5 year old children	25	41		41
total	51	78	31	109

(N is number of children)

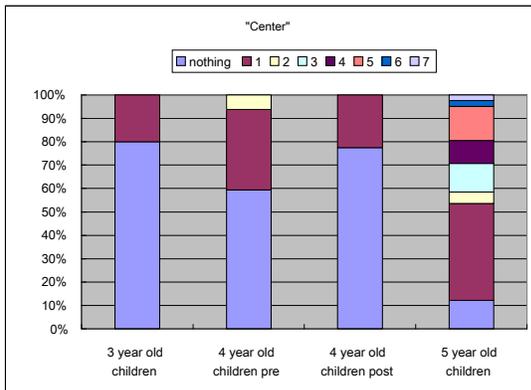
Table 1: Number of children and sheets

Though inside circle and outside circle in the model are both closed, children drew them by various opened and closed lines. [Grph.3] shows the case in the inside domain, and [Grph.4] in the outside domain. They could draw the closed line in the outside domain earlier than that of the inside domain.

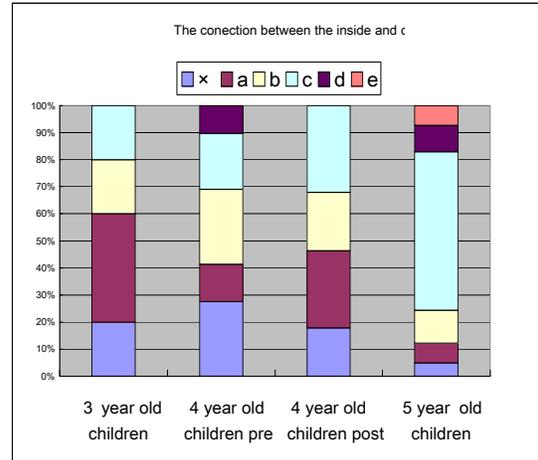
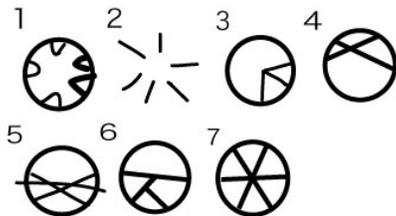
[Grph.5] shows the relation of connection of areas between the and the outside domain toward the center, from the standpoint whether they are directed toward the center. To fix the center, it is necessary for children that they can draw both the relation of connection and the direction of areas toward the center. Pictures are divided into several groups, 1: some without inner area, 2: some inner areas and outer areas are separated, 3: some inner and outer areas do not correspond, 4: in some both areas are corresponded but are incomplete, and 5: both areas correspond exactly. Though 3 year old children belong from 1, 2, 4, children 5 year old belong to 1~5. 4 year old children are in a transition period.

[Grph.6] shows if children take notice of the heterogeneous pair, ie. inner white area and outer green area, in the model. Other pairs are pink pairs, a blue pair, a yellow pair. It is important to watch whether children draw pairs without noticing the distinction between the inside and the outside areas, or noticing it.

To settle the center, they must be able to draw the relation of inside and outside, opened and closed, connection of areas, direction towards the center, combination of pairs. These are the elements for children to construct the concept of center.

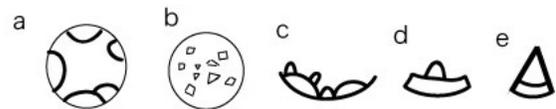


	nothing	1	2	3	4	5	6	7	total
3 year old children	4	1							5
4 year old children pre	19	11	2						32
4 year old children post	24	7							31
5 year old children	5	17	2	5	4	6	1	1	41



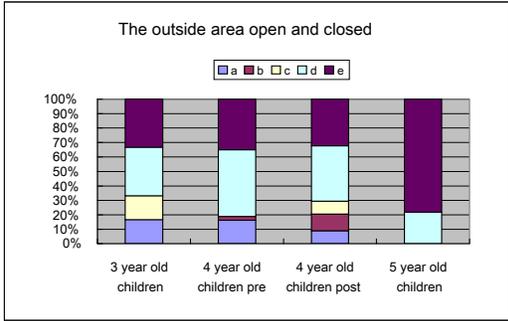
	3 year old children	4 year old children pre	4 year old children post	5 year old children
x	1	8	5	2
a	2	4	8	3
b	1	8	6	5
c	1	6	9	24
d	0	3	0	4
e	0	0	0	3

**Graph 1: Change in the cognition of center in accordance with age**

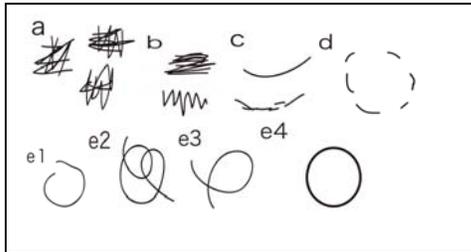


**Graph 2: Connection of the inside and the outside**

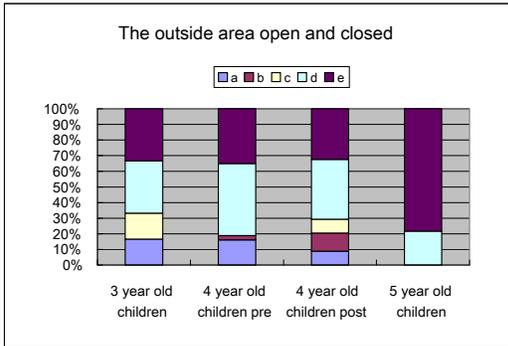
This paper was presented at VIPSI-2006 London. Author is with the Pedagogy Department, Miyagi University of Education, Japan. (e-mail: y-moto@miyakyo-u.ac.jp).



	a	b	c	d	e
3 year old children	2	1	0	0	0
4 year old children pre	13	6	2	8	1
4 year old children post	6	9	0	5	8
5 year old children	1	0	1	24	16

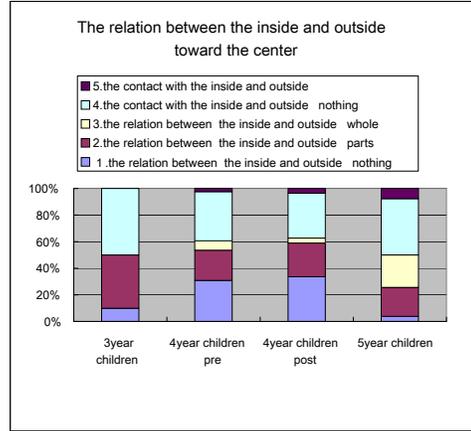


**Graph 3: Opened and closed in the inside domain**

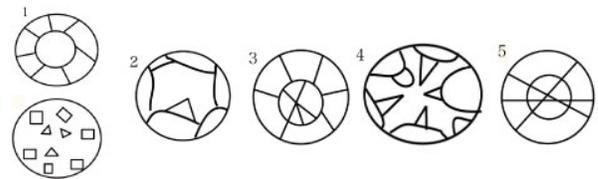


	a	b	c	d	e
3 year old children	1	0	1	2	2
4 year old children pre	6	1	0	17	13
4 year old children post	3	4	3	13	11
5 year old children	0	0	0	10	36

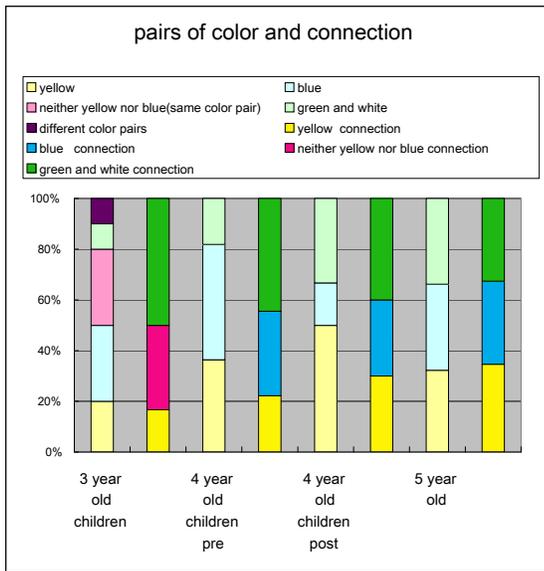
**Graph4: Opened and closed in the outside domain**



	3year children	4year children pre	4year children post	5year children
1.the relation between the inside and outside nothing	1	26	28	3
2.the relation between the inside and outside parts	4	19	21	17
3.the relation between the inside and outside whole	0	6	3	19
4.the contact with the inside and outside nothing	5	31	28	33
5.the contact with the inside and outside	0	2	3	6



**Graph5: The relation of connection between the inside and the outside domain toward the center**

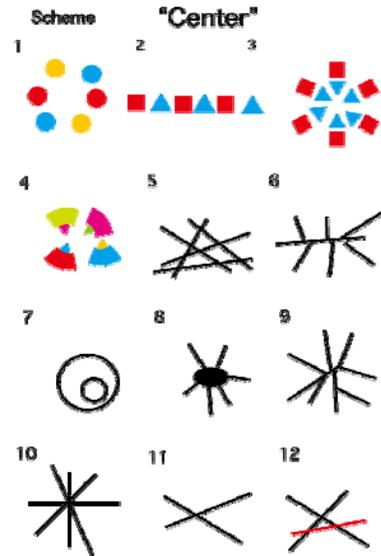


	yellow	blue	neither yellow nor blue (same color pair)	green and white	different color pairs	yellow connection	blue connection	neither yellow nor blue connection	green and white connection
3 year old children	2	3	3	1	1	1	0	2	3
4 year old children pre	4	5	0	2	0	2	3	0	4
4 year old children post	3	1	0	2	0	3	3	0	4
5 year old	19	20	0	20	0	18	17	0	17

**Graph6: Pairs of colors**

### Learning a center - Analysis of the pictures by 4 year old children

What do 4 year old children in the drawing of the model think and have trouble with in the course of their understanding of the center. We think 4 year old children stand at a turning point, because they are yet insufficient to understand the relation of elements or areas, they are yet undisciplined and have poor diversity, though they have great possibilities in development.



**Figure 2: Scheme : 12 Patterns : pair , alternation, axis, rotation and so on**

[Scheme ] is a devised table, divided into 12 patterns which mean pair, alternation, axis, rotation, and various <centers>—spread center, wide center, point center, and so on—. We will take some examples from children's pictures to illustrate these patterns. In the pictures of children we find a common step in the development of the cognition of center, from the cognition of pairs, to that of alternation, that of the connection, and that of the direction to the center.



**Figure 3: 12 illustrations : drawings by children**

## Cognition through the physical activity

We tried to elucidate the relation between the cognition of the center and physical activity. For this problem, children were told to play YOSAKOI dance after the first drawing. It is one of Japanese old folk dances, but we designed a new composition to this dance. Children were divided into two groups, red group and green group, and they danced looking at their tutors dance. We made no suggestion for the game, and we took notice of some movements in their behavior, to find what kind of movements they have learned from the tutor. We have analyzed these movement from the standpoint of centralization, and compared them with the drawings.

In the movements, there are noticeable elements, such as pairs and alternation, axis and rotation, center and circumference. Children learned in the movements noticing these elements, expressed them in their movement, and drew these <treasures> gained for themselves on the paper. In return, they made the best use of the understanding of the center in the drawing to their movements of the dance. Their cognition is one with their movement.



**Figure 4 Photo Movement : YOSAKOI dance**

We can see interesting relations between children's movements and drawings. Troubles in the movements are brought into the drawings. We find a noticeable coincidence between the troubles in the dance and those in the drawing (scheme).

- 1 Children make up pairs, but no reasonable movement to the center: scheme 1/2
- 2 At first turn to the right-hand, then to the left-hand : scheme 2
- 3 Movement of rotation in a pair around the other (children are told to move backward, feeling the other as an axis) : scheme 3
- 4 The pair connected with each other, but the

center of rotation moves around the supposed axis : scheme 4

5 Center and circumference are diverse among pairs (surround, neighborhood) ; scheme 5

6 Pairs move along a line : scheme 6

7 Pairs move along a circle, but have no attention to the center: scheme 7

8 Each member of a pair can not move around the center, though he is conscious of it : scheme 8/9

9 Each of a pair could not at first apprehend the center, but at the end of the play they could start approaching the center : scheme 10,11,12

## The learning of center and cognition of space by children

In the movement a teacher helps children that they can for themselves seek the center, distinguish the central area from the middle area, end area, and circumference. It is important for children to apprehend the expansion of areas for a start, and then take notice of the center. Many children at first have trouble to find the center, and step by step comprehend its position and meaning. The teacher must analyze their process of overcoming the troubles, and from this result understand <the logic of children>.

Our research to the problem of the cognition of center by children is done from the standpoint of topological geometry, such as the connection between two areas, opened-closed of contour lines. The problem of center in the movement by children is decisively topological, not Euclidean. In this point, many teachers have no ideas or misunderstand the problem. In topology the character of parts does not consist of the character of the whole. Teachers, who had learnt only Euclidean geometry, are apt to see in the learning of center only the Euclidean character of center and circle, and fail to lead the proper development of understanding in the cognition of space. Children learn the significance of the center from the necessity of their own lives and activities, not from the system of geometry.

Only from the standpoint to draw the model correctly, it is of course right that the center is one point. But as shown in many drawings of 4 year old children, there were various <center> - line center, domain center, moving center -. These centers may represent their troubles. But are they only negative or incorrect centers? And by which means do children develop their <category> of the center? To what extent does the center play a role in their lives?

In the movement of a dance, it is important for children to move vividly so that they can comprehend the relation between the center and themselves, their direction to the center, and their

part in the group or pair. Children who cannot see the relation between the center and circumference, the connection of areas, can not play a good partnership in pairs and have troubles in the dance.

The learning of the relation of the center and circumference is not significant only for the study of geometry but for the establishment of the self and for the relationship to others. By the topological and practical learning of the center, children can acquire appropriate action and thinking.

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