TRAMES, 2006, **10**(**60/55**), 4, 341–354

https://doi.org/10.3176/tr.2006.4.03

GENERIC REPRESENTATIONS IN CHILDREN'S DRAWINGS

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Abstract. To investigate drawing development, kindergarten (*N* = 213; age range 2;0–3;9- and Grade 1 (*N* = 183; age range 6;11–8;9) children performed Moore's (1986) colouring task. It was found that young children's drawings of a cube represent generalizations rather than particular models. An intermediate stage of differentiation between scribbles and representational drawings, closed forms, was identified. It was discovered that very young children often do not co-ordinate outline drawings with colouring. Outline drawing stage was correlated with colour use and co-ordination of colouring. Seven categories of ways how children colour in the single square that was drawn to represent the model cube were discovered.

Keywords: children's drawings, colouring task, coloured cube drawing, generic representations, stages of drawing development

1. Generic representations in children's drawings

It was suggested already by Luquet (1927) that drawing development proceeds over four phases. First scribblings or involuntary designs are followed by fortuitous realism, after that intellectual realism develops, and finally drawings are characterized by visual realism. In other words, there is a phase in children's drawing development where they "draw what they know" rather than "what they see." Later studies have demonstrated that even though relatively young children can draw what they see (they may include view-specific information in their drawings) there is still a shift in emphasis from one kind of depiction to another (e.g. Cox 1992, 1993). It is also noteworthy that drawings of young children often do not refer to any particular object but to a generic type (Gardner 1980, Luquet 1927, Milbrath 1998).

In order to differentiate between drawings that represent a generalization and drawings that represent particular models, it is necessary to know exactly what model a child drew. In case of free drawings it is not very often clear which model the child intended to draw. In case of model drawings, however, it is also not easy to differentiate generalized drawings from exemplar drawings. Some models may not have distinct characteristics. Even if a model has distinct characteristics it would always be possible that a child's attentional capacities are limited, and distinctive characteristics were not drawn because a child drew a generalization, but rather because she or he "forgot" to draw those particular attributes. This obstacle was taken into account in a study by Toomela (2003b). He presented children a model of an unusual doll, which had *fewer* attributes than usual dolls. Drawings of a doll were coded as follows: scribbles or patterns; prototypical drawings of a doll where more attributes are drawn than characterize the model; 2-D-exemplar drawings where only attributes of the model are depicted, but the drawing is not in perspective; and 3-D-exemplar drawings of the model drawn in perspective. It was found in this study that children before the age of three years and ten months drew only scribbles or prototypical drawings of a doll. Before the age of eight years, the most typical drawings were also prototypical. In this study a cube was also presented to children as a model. Cube drawings were coded as suggested by Toomela (1999) into four categories: scribbles and patterns, single squares, figures differentiated into faces with visually not realistic relationships between faces, and integrated wholes drawn in parallel or convergent perspective. It turned out that the two coding systems, that of a doll and that of a cube, were significantly related even when the effect of age was partialled out. Thus, prototypical drawings of the doll were accompanied by earlier stages of drawings of a cube. This is indirect evidence that earlier stages of cube drawings may actually be drawings of a cube generalization rather than the particular model.

In the studies of drawing development, cube has been one of the most popular models. Therefore, it would be interesting to establish whether drawings of a cube may also be generalizations in earlier stages of drawing development. Drawings of a usual cube cannot be informative in that respect because there are no distinct attributes of the model that could be omitted or added. In order to determine the child's intention in making an outline drawing of a cube, Moore (1986) used a colouring task, in which each face of a cube presented to children was painted a different colour. She discovered that 7-year-old children included more hidden faces of the object in their drawings than 9-year-old children, but the colours used were always correct colours. Younger children drew in addition to viewpoint specific faces also faces of the model hidden from their viewpoint. In addition, it was also found in this study that outline drawings comprising a single square represented in some cases, especially in younger children, the whole object rather than a particular face of the model. Younger children used more than one colour in horizontal or vertical stripes for colouring in the single square. Older children used only one colour indicating the front face of the cube.

Moore's colouring task can be used for determining whether very young children draw prototypes or exemplars. In her study children used only correct colours, which suggest that children drew the model. In Moore's study, however, younger group constituted primary school children with mean age 7 years 5 months (SD = 3.4 months). Toomela's (2003b) findings, however, suggest that generalized drawings should characterize considerably younger children, especially children before the age of four years.

Five hypotheses were tested in this study. First, we assumed that younger children, especially before the age of three years and ten months, represent generalizations rather than specific models. They do not pay attention to particular colours of the cube. They just represent the knowledge that the model was "with some colours" rather than "this particular model was coloured with these particular colours."

Second, there should be another developmental change in colour use. In addition to a shift from using incorrect colours to correct colours, it can be suggested on the basis of Moore's findings that there should also be another shift from using both hidden and visible model-specific colours to vantage-point specific use of colours.

The third hypothesis was related to the earlier stages of a cube drawing development. Toomela (1999) coded into the same category both scribbles and closed forms. Development proceeds from a state of relative globality and lack of differentiation to a state of increasing differentiation, articulation, and hierarchic integration (Werner 1978). It has been found that early scribbles are based on a substratum of symbolization, which is as much to do with movement and time as they are with configuration (Matthews 1984). Scribbles can, thus, represent different kinds of information, not only visual. We speculate that closed forms (usually imperfect circles) may represent differentiation in drawing development: symbolically heterogeneous scribbles differentiate into configurations in the shape of closed forms. These forms, as a phase in differentiation, however, should not be visually representational as yet. Therefore, we expected to find that closed forms are later development than scribbles; closed forms should developmentally appear between symbolically heterogeneous scribbles and representational drawings of single units (generalizations). In other words, we suggest that very early drawing development proceeds over two phases of differentiation. First scribbles, representing in addition to configurations also motor and time aspects of models differentiate into non-representational closed forms that do not convey motor or time information any more. Closed forms, in turn, differentiate into generic representational drawings of models.

Fourth, following Toomela's (2003b) indirect evidence, we expected to find that stages of outline drawings (scribbles-single units-differentiated faces-integrated wholes; cf. Toomela 1999) correspond to the use of colours. Young children who draw scribbles and single squares should tend to use incorrect colours along with correct colours, whereas later stages should be characterized by the use of only correct colours.

According to our fifth hypothesis, we expected to replicate Moore's findings about the meaning of a single unit (square) drawn by children at different ages. Younger children should use more than one colour for colouring in the single square, whereas older children should more often use only one colour.

2. Method

2.1. Participants

There were 396 participants from six different kindergartens (*N* = 213) and five different schools (*N* = 183). The participants were divided into three age groups. There were 38 participants in the Younger Kindergarten (YK) group (age range 2;0–2;5, corresponds to Period 1 in Toomela 1999); 175 participants in the Older Kindergarten (OK) group (2;6–3;9, corresponds to Period 2 in Toomela 1999); and 183 participants in the Grade 1 (G1) group (6;11–8;9, corresponds to "infant" group in Moore 1986). The proportion of boys and girls was about equal in all groups.

2.2. Materials

The stimulus for drawing was a cube whose faces measured 8 × 8 cm. Each face of the cube was painted a different colour. A pencil and paper was provided and 10 felt-tip pens were made available for the task. These represented the six colours used for painting the coloured cube plus an additional four different colours.

2.3. Procedure

All children performed two tasks. These were (1) exploring and then copying with a pencil the coloured cube; and (2) colouring in the copy. Participants were tested individually. Each child was shown a coloured cube and was encouraged to pay attention to different colours of the cube. It was then placed on a table in a standard orientation for copying, about 50 cm away from a child and slightly to his/her left, such that a top, front and right faces were visible. Children were asked "to draw exactly this." After a child completed a drawing, an experimenter removed the pencil, gave him or her 10 coloured pens and asked to colour in their drawing.

The colouring task was presented among several other cognitive tasks measuring memory, perception, conceptual thinking, and vocabulary. All participants were also asked to draw a model of a car, a model of a doll, and a piece of a tube. Results of these tasks will not be reported here.

2.4. Coding

The drawings of cubes were coded into one of the five categories (see Toomela 1999 for details): Category 1 (*Scribbles*), Category 2 (*Closed Forms*), Category 3 (*Single Unit*), Category 4 (*Differentiated Figures*), and Category 5 (*Integrated Whole*). For coders the categories were described as follows. *Scribbles*: In this category the models are represented with scribbles. It is not possible to decide what scribbles refer to what model. *Closed Forms*: In a case of closed forms the same form must have been used for representing different models so that it is not possible to decide what form refers to what model. *Single Unit*: A cube was classified into this category only when it was (and other models were not) represented with a single square. *Differentiated Figures*: volumes in drawings are differentiated into faces. The drawings are not in the oblique or perspective projection, and the depth dimension of a volume is not realistically depicted. *Integrated Whole*: oblique or perspective projection drawings of the cube.

The coders received the following training. First, the author of the taxonomy characterised its four stages theoretically. After that every coder coded the same 30 drawings randomly selected from the database. Then the coders compared the results of coding with each other, the disagreements were discussed until an agreement was found. All further coding was performed by coders independently from one another.

The drawings were coded by six assistants and by the author. In addition, 45 randomly selected drawings of a cube were coded independently by two coders (there were three pairs of coders, each pair coded 15 drawings) for checking the inter-rater reliability. Inter-rater agreement was adjusted for chance, Cohen's $\kappa = 0.88$.

In addition to cube drawing category, the use of colours was coded. There were three possible categories of colour use: Among other colours some that did not characterize the model were used (1); only colours of the model were used, in addition to three colours visible from a viewpoint of a child some hidden colours were used (2); only vantage-point specific correct colours were used (3).

In categorizing drawings we discovered an interesting peculiarity of colour use not reported before. Some children did not co-ordinate contour drawings of a model with colouring; colours were drawn in a different place than the original cube drawing. We found that some children scribbled colours as if following a rule, "a separate space for every colour;" the other children, in turn, chose a separate place for colours, but put different colours one onto another. So we coded drawings additionally into two categories: Colouring was not co-ordinated with a pencil drawing (0), and colouring was co-ordinated with a pencil drawing (1).

2.5. Data analysis

We were interested in possible similarities and differences between groups of children differentiated according to age. Our data were categorical. In order to analyze patterns of categories in different age groups, we used Configurational Frequency Analysis (CFA; von Eye 1990). CFA is a multivariate method for typological research that involves categorical variables. CFA compares the observed and expected frequencies in a cross-tabulation for every cell in a table. The results of the analysis reveal "Types" (observed frequency is significantly higher than expected frequency) and "Antitypes" (observed frequency is significantly lower than expected frequency). An exact test for the comparison of observed frequency with expected frequency is the binomial test. Because it makes no assumptions concerning the underlying distributional parameters, the binomial test is conservative. The analysis was performed with the CFA program Version 2001 (Von Eye 2001).

3. Results

Results of the CFA, observed frequencies, expected frequencies, and *p* - values are shown in Table 1.

Table 1 Number of observations, expected frequencies, and binomial p values at each age group

Drawing type/	Age group								
Co-ordination/	Younger kindergarten (N = 38)			Older kindergarten (N = 175)			Grade 1 (N = 183)		
Colour use	fo	fe	p	Fo	fe	p	fo	fe	p
Scribbles, not co-ordinated									
Incorrect	**16**	**1.245**	**.00000**	**41**	**5.732**	**.00000**	0	5.994	.00238
Correct visible/invisible	4	.597	.00327	6	2.751	n.s.	0	2.877	n.s.
Correct visible	2	1.444	n.s.	7	6.649	n.s.	0	6.953	.00089
Scribbles, co-ordinated									
Incorrect	**12**	**2.863**	**.00004**	16	13.184	n.s.	***0***	***13.786***	***.00000***
Correct visible/invisible	1	1.374	n.s.	4	6.328	n.s.	0	6.617	.00126
Correct visible	0	3.321	.03562	4	15.293	.00058	***0***	***15.992***	***.00000***
Closed forms, not co-ordinated									
Incorrect	3	.881	n.s.	**23**	**4.058**	**.00000**	0	4.244	.01403
Correct visible/invisible	0	.423	n.s.	6	1.948	.01450	0	2.037	n.s.
Correct visible	0	1.022	n.s.	10	4.707	.02169	0	4.923	.00706
Closed forms, co-ordinated									
Incorrect	0	2.027	n.s.	**23**	**9.333**	**.00009**	***0***	***9.760***	***.00005***
Correct visible/invisible	0	.973	n.s.	10	4.480	.01606	0	4.685	.00898
Correct visible	0	2.351	n.s.	5	10.827	.03963	***0***	***11.322***	***.00001***
Single unit, not co-ordinated									
Incorrect	0	.595	n.s.	0	2.739	n.s.	0	2.864	n.s.
Correct visible/invisible	0	.285	n.s.	2	1.315	n.s.	0	1.375	n.s.
Correct visible	0	.690	n.s.	0	3.177	.04116	0	3.323	.03555
Single unit, co-ordinated									
Incorrect	0	1.368	n.s.	8	6.300	n.s.	3	6.588	n.s.
Correct visible/invisible	0	.657	n.s.	3	3.024	n.s.	**12**	**3.162**	**.00011**
Correct visible	0	1.587	n.s.	3	7.308	n.s.	**23**	**7.642**	**.00000**
Differentiated figures, not co-ordinated									
Incorrect	0	1.487	n.s.	0	6.848	.00099	0	7.161	.00073
Correct visible/invisible	0	.714	n.s.	0	3.287	.03686	0	3.437	.03167
Correct visible	0	1.725	n.s.	***0***	***7.944***	***.00033***	***0***	***8.307***	***.00023***
Differentiated figures, co-ordinated									
Incorrect	0	3.420	.03222	***2***	***15.750***	***.00002***	***3***	***16.470***	***.00005***
Correct visible/invisible	0	1.642	n.s.	1	7.560	.00422	**22**	**7.906**	**.00002**
Correct visible	0	3.967	.01855	***1***	***18.270***	***.00000***	**106**	**19.105**	**.00000**
Integrated whole, Not co-ordinated									
Incorrect	0	.154	n.s.	0	.710	n.s.	0	.743	n.s.
Correct visible/invisible	0	.074	n.s.	0	.341	n.s.	0	.356	n.s.
Correct visible	0	.179	n.s.	0	.824	n.s.	0	.861	n.s.
Integrated whole, not co-ordinated									
Incorrect	0	.355	n.s.	0	1.633	n.s.	0	1.708	n.s.
Correct visible/invisible	0	.170	n.s.	0	.784	n.s.	1	.820	n.s.
Correct visible	0	.411	n.s.	0	1.895	n.s.	**13**	**1.981**	**.00000**

Note: fo = observed frequency; fe = expected frequency. **Types** are in bold and ***Antitypes*** in bold and italics (Only Bonferroni adjusted alpha < .00056 are marked)

3.1. Generic representations in children's drawings

We hypothesized that younger children do not pay attention to particular colours they use for colouring in the pencil drawing. We found that 31 children (82%) in the YK, 113 children (65%) in the OK, and only 6 children (3%) in the G1 used incorrect colours in their drawings. The results of CFA (Table 1) demonstrate that only drawings where incorrect colours were used were typical in the YK and in the OK. In G1, however, drawings with incorrect colours were either antitypical or neither typical nor antitypical. Thus, very young children quite often do not pay attention to specific colours of the model.

3.2. Use of hidden colours

Next, hidden but correct colours together with visible colours were used by 5 children out of 7 who used only correct colours (72%) in the YK. In the OK, respective numbers were 32 out of 62 (52%), and in the G1 respective numbers were 35 out of 177 (20%). Thus, as expected, from children who used only correct colours in the colouring task, the proportion of children who used both visible and non-visible colours decreases systematically with age. It is also noteworthy that, according to CFA, drawings where only visible and correct colours were used were typical only in the G1, in younger groups correct vantage-point specific colour use was either antitypical or neither typical nor antitypical.

Taken together, the data suggest that colouring proceeds over three phases in performing the colouring task. First children do not pay attention to the colours of the model, both correct and incorrect colours are used. Next "intellectual realism" drawings appear; children draw correct colours but include both visible and hidden colours of the model in their drawings. Finally, only correct vantage-point specific colours are used by older children.

3.3. Closed forms

Analysis of pencil drawings revealed that closed forms drawn by children could be understood as an intermediate step between scribblings and single units. Only 3 children in the YK drew a closed form, all other children created scribbles when requested to draw the model of a cube. Only scribbles were typical in YK according to CFA. In OK, however, both scribbles and closed forms were typical. Finally, children in the G1 never used scribbles or closed forms when requested to draw a cube.

3.4. Co-ordination of colouring with a pencil drawing

Incoordination characterized drawings of 25 (66%), 95 (54%), and 0 (0%) children in YK, OK, and G1, respectively. Thus, there is a clear developmental shift from incoordinated to coordinated drawings.

3.5. Category of cube drawing, co-ordination, and colouring

We hypothesized that pencil drawing category should be related to colouring. As can be seen in Table 1, incorrect colours were never used in case of perspective drawings (Category 5), in case of Category 4 cube drawings incorrect colour use was antitypical. Incorrect colour use was typical in case of scribblings (Category 1) and closed forms (Category 2). Pencil drawing category was also related to co-ordination. Category 4 and 5 drawings were without exception co-ordinated with colouring. Category 3 drawings were uncoordinated only in two cases out of fifty-four. At the same time, Category 1 and 2 were uncoordinated in about half the cases.

It was still possible that the three scales were related only through age. To test that possibility we estimated the correlation between different drawing scores in the path analysis model where the effect of age was directly taken into account. Path analysis is a type of modelling technique for studying the direct and indirect effects of variables taken as causes (or "independent variables") on variables taken as effects (or "dependent variables"). Path analysis is an extension to multiple regression and like multiple regression, helps to analyse the structure of the data. In path analysis each dependent variable is regressed on every independent variable that is predicted to affect it. The resulting regression weights indicate the strength and direction of the relationships among the hypothesised variables.

We conducted a path analysis with the model where age was supposed to have an effect on the pencil drawing category, co-ordination of colouring with pencil drawing, and colour use. Three characteristics of drawings were allowed to correlate. Drawing scores were treated as ordered polytomous variables. The model was analysed and the weighted least square parameter estimates with robust standard errors of the model were generated with Mplus 1.0 (Muthen & Muthen 1998). The initial model did not converge. The most common reason for such a problem is that some levels of the categories are relatively infrequent. The inspection of the data revealed that, indeed, Category 5 (Integrated Whole) of cube drawings comprised only 3.5% of the observations. We took two different approaches to overcome that obstacle. First, we treated pencil drawing category as a continuous variable. This should not create substantial problems because there were five levels of drawings; the scale should not be overly coarse. The analysis revealed that all three different characteristics of drawings were significantly influenced by age. The parameter estimate and robust standard error for the effect of age on pencil drawing category were 0.040 and 0.001, respectively; for a coordination of colours and pencil drawings 0.083 and 0.018, respectively; and for colour use .034 and .002, respectively. All effects are statistically highly significant ($p < .0001$). The estimated relationships between pencil drawing category and coordination of colouring (parameter estimate = .111; robust standard error = .046; $p < .05$) and between pencil drawing category and colour use (parameter estimate = .110; robust standard error = .034; $p < .005$) were statistically significant as well. There was no statistically significant relationship between co-ordination and colour use after the effect of age was taken into account (parameter estimate = –.077; robust standard error = .110; *p* = n.s.). The second approach where we treated all drawing characteristics as continuous variables and generated the Maximum Likelihood parameter estimates, led to similar results: all drawing characteristics were significantly affected by age. The pencil drawing category was significantly correlated with co-ordination and colour use, there was no significant correlation between the latter two variables after the effect of age was taken into account.

Thus, we can conclude that the correspondence between the pencil drawing category and colour use was not caused only by age. It is noteworthy that the statistical analyses that supported this conclusion were very conservative because the hypothetical common mechanism that relates pencil-drawing category with colour use and co-ordination develops with age too.

3.6. Meaning of single units (squares)

Our data also allow to better understand the child's intention in making single unit drawings (squares). Moore (1986) found that 9-year-old children, who represented a cube with a single square, used the one colour indicating the front face of the cube, whereas all 7-year-old children used all correct six colours, in vertical or horizontal stripes. Instead of two, we found seven types of colouring (see Figure 1 for the types of colouring of a single square).

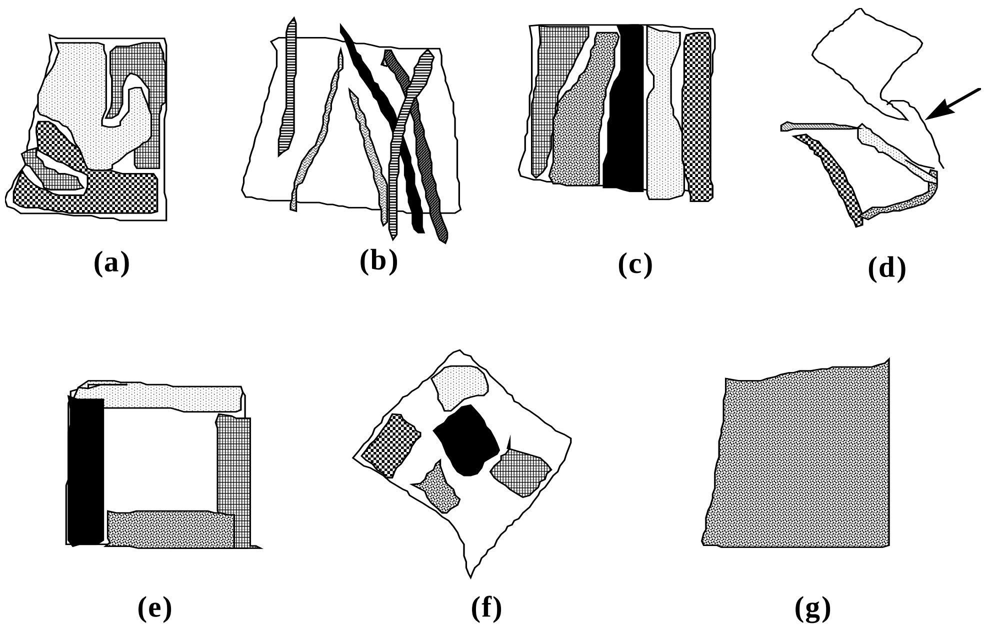

Figure 1. Children's drawings of a coloured cube. Colouring types.

In the OK six types of drawings were found. Four children filled the square with irregular patches of different colours (Figure 1a). Next, two children drew more or less parallel lines with different colours; some colours were represented with two lines (Figure 1b). Four children coloured a square with vertical or horizontal stripes similar to those observed by Moore (Figure 1c). Fourth, three children represented faces of the cube with a single line as depicted in Figure 1d. In two cases the drawing was co-ordinated as in lower part of Figure 1d (in these cases in addition to lines, the inside of the square was coloured with one colour). In one case a very interesting incoordinated solution to the colouring task was created by a child (Figure 1d). He first drew a single square with a pencil. Then he created another square using a different colour for every side of the square. After that he connected the coloured square with a pencil drawing with a line (that line is marked with an arrow in Figure 1d) to indicate that the same cube was represented with both rectangles. It is noteworthy that this child explicitly compared the colours he used with the colours of the model. Thus, this drawing was not generic. Fifth, one child drew quite regular small coloured rectangles, all with a different colour, in the region surrounded by a pencil drawing (Figure 1f). And finally, two children filled a square with one colour (Figure 1g).

Five types of drawings were found in G1. One child created a drawing, which is analogous to 1d with the exception that colouring was co-ordinated with the square, every side of the square was coloured with a line of different colour. In one case instead of single lines, thicker stripes were drawn with every side of a rectangle coloured with a different colour (Figure 1e). Next, one child drew small coloured rectangles in the region surrounded by a pencil drawing (Figure 1f). Finally, fifteen children coloured a square with vertical or horizontal stripes (Figure 1c) and twenty children filled a square with one colour (Figure 1g).

3.6.1. The meaning of squares

The results of colouring single squares are in agreement with the idea that for younger children the square represents the whole cube (only 13% of the OK children coloured the rectangle with one colour), whereas for older children the square may represent one face of the cube (53% of the G1 children used only one colour for filling in the whole square).

3.6.2. The meaning of lines

Our evidence suggests that in some cases (Figure 1d and 1e) a side of a rectangle drawn with a single line represents a face of the coloured cube. In other cases (Figure 1a, 1b, 1c, and 1f) the inside of the square represents undifferentiated faces of the whole cube.

4. Discussion

Our aim was to study general categories in children's drawing development. Both quantitative and qualitative evidence suggests that there is a stage in drawing development where children draw a generalization rather than a particular model (Gardner 1980, Luquet 1927, Milbrath 1998, Toomela 2003a, 2003b). With some models the generic nature of a drawing can be established relatively easily. In other cases, as with the most popular geometric model object in studies of drawing development – a cube – generic and model-specific drawings cannot be easily differentiated.

In this study Moore's (1986) colouring task was used for studying different aspects of drawing development. We found, first, that colouring of the model proceeds over three phases. First children do not pay attention to the model and use both correct and incorrect colours. This colour use suggests that children represent in their drawings a general fact that the model was coloured. Next children use only colours that characterize the model, but they use colours that are both visible and hidden from their vantage-point . Children, thus, draw particular models, but they tend to draw "what they know" about the model rather than "what they see." Finally, children begin to use only correct vantage-point specific colours.

Next, we hypothesized that closed forms may represent an intermediate phase of drawing development between scribbles and representational drawings. Indeed, closed forms clearly appeared after scribbles. At the same time closed forms could not be interpreted as representational drawings because by our definition, a drawing was categorized a closed form only when the same form was used for representing more than one clearly distinguishable model. It has been demonstrated that scribbles may symbolize, in addition to configuration, also time and movement (Matthews 1984). Closed forms do not represent time and movement, at least not in the same way as scribbles, because they are produced by one movement, similarly used in denoting different models. Thus, closed forms can be understood as a phase of differentiation in drawing development; an intermediate step between symbolization of multiple qualities of the model with an undifferentiated scribble on the one hand, and only visual qualities in a representational drawing on the other hand.

In the process of categorizing children's drawings we discovered a very interesting quality of drawings. Many young children did not co-ordinate contours of the model with colouring. Contours were produced in one place and colours in other places on the paper. Co-ordination of drawings increased with age so that 66% of youngest children produced uncoordinated drawings and schoolchildren always co-ordinated pencil drawings with colouring.

The Moore colouring task helps to understand children's intentions in making different kinds of outline drawings of a cube. Data analysis showed that outline drawing development was correlated with colour use and co-ordination of colours even when the effect of age was partialled out. Scribbles and closed forms were characterized by uncoordination of drawings and incorrect colour use. Uncoordination also characterized rare instances of drawings where a cube was represented with a single square. Differentiated Figures and Integrated Wholes were always coordinated with colouring. Incorrect colour use characterized mainly scribbles and closed forms, it was also relatively common with Single Units (especially in younger children). In rare cases incorrect colours were used for colouring in Differentiated Figures, Integrated Wholes were always coloured in with correct colours. Thus, our data suggest that generalization characterizes also drawings of cubes by young children.

Finally, children's intention in making single unit drawings (squares) can be better understood as well. Our evidence supports Moore's observation that single square represents the whole cube for younger children whereas for older children single square increasingly represent the front face of the model cube. Interestingly, we discovered seven different categories of ways how children colour in the square. Two of them, colouring in with vertical or horizontal stripes (Figure 1c) and filling a square with one colour (Figure 1g), were also observed by Moore. In two other categories some areas were covered by a colour (Figure 1a, 1f). In these categories a line used for drawing a single square possibly stood for a whole contour of the model. In three categories (Figure 1b, 1d, 1e), however, colours covered the lines used for drawing a rectangle. It might be possible (especially in case of 1d and 1e) that for some children a line stands for a face of a cube rather than for a contour.

Taken together, the data suggest that drawing development like development in general (Werner 1978) proceeds from an undifferentiated state into a state of differentiation followed by integration of differentiated components. An integration line of development was in our study characterized by the development of coordination between pencil drawing and colouring. Two lines of differentiation were observed in our study. One line of differentiation was observed in colour use. In early phase of development, colours were used just for denoting the fact that the model was coloured. Later colours that characterize the model were used. Finally only vantage-point specific colours were used. The other line of differentiation can be seen in outline drawings. Symbolically undifferentiated scribbles differentiate into closed forms. Next closed forms differentiate into representation of the model where a region stands for a whole volume. Single wholistic units, in turn, differentiate into depictions of different faces of the model. Finally, viewpoint specific visually realistic perspective drawing develops. Similar stages of differentiation have also been observed in other studies (Toomela 1999, 2003b, Willats 1992, 1995, 1997).

Our data, together with evidence provided by other studies (Gardner 1980, Luquet 1927, Toomela 2003b) are in agreement with the idea that in early phases of differentiation children rely on generic representations in their drawing performance. They draw a generalization rather than a particular model. A phase in the development where children mainly rely on generic concepts may characterize not only drawing development but also development of other cognitive abilities and skills (e.g. Toomela 2000, 2003a).

Acknowledgements

This research was supported by the Estonian Science Foundation Grant No 5388.

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