Part-Whole Relations: Some Structural Features of Children's Representational Block Play

Stuart Reifel
Patricia Marks Greenfield
The University of Texas at Austin
University of California, Los Angeles

ABSTRACT: Research is reported that shows how block play becomes more complex with respect to part-whole relationships with the child's increasing age. Older children include a greater number of constituent parts in their constructions. Constructions appear to reveal knowledge of parts before the child uses spontaneous language to indicate parts.

One important aspect of young children's cognitive development is part-whole relations. As children grow to know more of the world and as their cognitive structures mature, we expect to see in their behavior a better understanding of the relationship of parts to the whole. For example, with regard to a physical self-concept, the child comes to understand that the body (a whole) consists of hands, face, legs, feet and so on (parts). Each of these, in turn, consists of parts, so that a face comes to be known as the constellation of eyes, mouth, nose, cheeks, chin, ears, and so on. With regard to knowledge about social relationships, the child builds a concept of family (a whole) from experience with siblings, parents, and anyone else who is a part of the whole family. Part-whole relations are one way the child has for creating order in the world, for structuring knowledge in a manageable way.

The development of part-whole relations in early childhood is described by Piaget (1962) as progressing from a time when the child demonstrates "infra-logic" to a later stage of concrete logical operations. Infra-logic involves the partitioning of elements within an object, such as locating the eyes, nose and mouth of a face. This might first be demonstrated through sensory motor action (perhaps pointing or grabbing), then through depiction (possibly naming or drawing). This manifestation of infra-logic precedes the child's ability to operate on classes of objects, when the child can form classes or groups of objects and manipulate them logically. Those objects that the child deals with in the period of infra-logic become the material that can be operated on logically in the stage of concrete operations.

Thus, the eyes, noses, mouths and other features that 3-and 4-year-olds distinguish from one another serve as information that helps them later form rules about the composition of a class of human faces (i.e., class composition); human features are associated with human faces, cat features with cat faces, and fish features with fish faces. It also serves as material for categorization (e.g., people with blue, brown, or grey eyes; people with black, brown, or fair skin). The learning a child has during this phase of infra-logical thinking provides basic information that is reorganized and used at a later stage in cognitive growth. When children are older, they make use of operations that develop from preoperational schemes that allow them to function with mathemathical computation, reading, and other thinking tasks.

In early childhood classrooms, we attend to the child's functioning with part-whole relations through any number of activities, such as by having the child work with picture puzzles, by encouraging the formation of groups of sets that are alike or different in certain ways, and by asking the child questions like "Does that doll have all her clothes?" By providing children with activities such as these, we try to enhance understanding of how things relate to one another. That is, we call attention to concepts that can be more fully understood by focusing on the connectedness of constituent parts and the totality.

Children's classroom play with building blocks is a good source for learning about part-whole relations. Children begin to play with blocks in any number of ways, including toting them, stacking them, or creating patterns with them. By the age of four, children usually show some interest in using blocks representationally (Johnson, 1974; Guanella, 1935). That is, they use blocks to stand for objects or events that they have experienced, such as farms, roads, houses, train stations, and so on. These block representations of houses and roads are significant, because they reveal how the child's mind can deal with referents, such as houses and roads. These block representations are symbols that stand for houses and roads in child play.

Symbols can be more or less complex in a number of ways. The child can deal with a referent, such as "a house," as a complex structure, having many parts (e.g., walls, roof, doors, chimney), or the house can be seen by the child as a less complex unit. Blocks can be used in any number of ways by the child to stand for this house, showing more or less of its structural complexity and part-whole relationships.

Objects that serve as referents for children can also be analyzed into their component parts. For example, a house can be seen simply as a house or alternatively as the combination of floor, roof, walls, windows, doors, chimney, and so on. The child can include more or fewer of these parts in a representation. In addition, the child may talk

about some or all of the parts that have been included in a representation.

Current research on block construction has viewed different types of part-whole relations. Reifel (1981; Note 1) found that older children represented more parts of a story with blocks than younger children did, paralleling research findings on story grammar (e.g., Brown, 1975; Stein, 1979). Reifel and Greenfield (1982) demonstrated several dimensions of representational block structures (i.e., individual block configurations that stand for something else, such as houses, trees, or paths) that reflect developing mental skills. In this article some features of representational block structures are investigated. Specifically, the purpose of this article is to describe the increasing part-whole differentiation that accompanies increasing age in representational block construction.

Method

A sample of spontaneously constructed block structures that were created by 20 4-year-olds and 20 7-year-olds served as the focus for our analyses. These constructions were generated for a study on the development of representational block play (Reifel, 1981, 1982,). Each child worked individually with an experimenter, who read the child a version of the story of *Little Red Riding Hood.* After hearing the story the child was asked to "Use the blocks to show me the story we just read." Among the many things that the children did create with the blocks were houses, paths, trees, and characters, all from the story. For example, a four-year-old girl constructed the grandmother's house, trees, a sidewalk, flowers, a road, a bridge, and a slide. A seven-year-old boy constructed grandmother's house, Little Red Cap's house, and the path that connected them. Photographs and videotapes were made of each child's construction, so they could be coded at a later time.

Most of the children (80%) in our sample constructed at least one house, and a large number of those children (76%) described, or labeled, their houses in some detail. This provided us with data for investigating the ways that children represent parts of a whole house, and also data on the language (i.e., labels) that accompanies part-whole understandings. Because our data are most complete for an analysis of constructed houses, we have limited our present presentation to what we have learned about block houses.

Two coders independently inspected each child's photographs in order to decide what house parts (chimney, doors, roofs, walls, floors)

could be recognized or distinguished. The coders agreed on 90% of their judgments regarding the presence or absence of those five house parts. These data provided insight regarding children's representation of part-whole relationships, at least with reference to a constructed house.

Two coders also listed each label that a child provided for a construction, agreeing on 97% of the cases for all the sample. These data provide some perspective on the child's verbal understanding of parts within the whole house.

Results

How many parts are included in children's whole symbols? In terms of the parts included in each child's house (doors, walls, roof, floor, chimney), a point was given to each child for each part included in the house (as viewed by the two observers). The 4-year-olds included an average of 2.17 house parts, and 7-year-olds included an average of 3.15 house parts. That difference is statistically significant ($t=3.27$, $p<.01$, $df=30$). Older children's houses showed more house parts. The extreme case of children not showing house parts in constructions was demonstrated by three 4-year-olds who used a single block to stand for a house. It was only younger children who used this simple, undifferentiated symbol to stand for a house; all older children constructed houses that were more complex.

What parts are included in block houses by children of different ages? Roofs and walls seemed to be frequently included house parts for children at both ages four and seven, and chimneys were nearly as common for children at both ages. Floors were uncommon at both ages, perhaps because when a child is building, no floor needs to be built. One house part did become more frequent as children grow older; only 8% (1 out of 12) of 4-year-olds constructed doors, while 70% (14 out of 20) of 7-year-olds did so (Fisher exact $p=.005$).

What differences are there in the use of labels for house parts at the two ages? Older children used an average of 2.56 labels for their constructed houses. This was significantly higher than the average 1.85 that younger children used ($t=2.29$; $p<.05$, $df=24$) (See Table 1). Older children were more likely to construct houses with more parts, and they were more likely to name more parts as well.

Since we also had children's verbal descriptions of their constructions, we compared the children's verbal understanding of parts to their constructions of the whole. Interestingly, in many cases children

Table 1

Constructed and Labeled House Parts

	Constructed[a]		Labeled[b]	
Age	Mean number	S.D.	Mean Number	S.D.
4	2.17	.94	1.85	.58
7	3.15	.75	2.56	.87

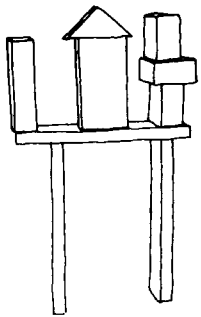
at both ages constructed a house part (e.g., roofs and walls) before they verbally labeled it. They appeared to have some knowledge of the house that they did not spontaneously express with language. Children seemed to express some of what they knew of part-whole relations through constructions and not as spontaneously with language.

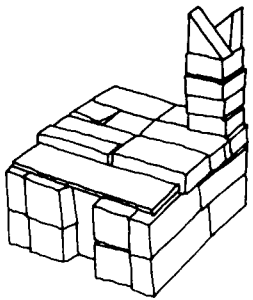
Figure 1 shows some typical representations of houses at two age levels, with the child's label of parts that accompany them. The 4-year-old's house shows what might be seen as a house frame, with walls, a roof, and with a chimney added to the top. The child viewed the arch-shape as a doorway. In constrast is the 7-year-old's house that is shaped like a 3-dimensional house and has a door included as well as a chimney.

Discussion and Conclusion

It appears that block constructions do reflect children's increasing cognitive development with regard to part-whole relations. Older children do more frequently include a greater number of parts in their spontaneously produced representations of houses, and they generate a greater number of labels of parts for the whole representation. By inspecting representational block constructions in the classroom, we can begin to understand children's knowledge of part-whole relationships at different stages of development. With that knowledge, we can plan instruction for children that will add to their knowledge of parts and how those parts relate to the whole. Some of the many implications for encouraging and interpreting representational block play in the classroom are enumerated elsewhere (Reifel, 1982).

To make use of this knowledge in the classroom requires little more than observing what the children are doing with the blocks and asking





	Parts Labeled by Child	Parts Constructed by Child
Chimney	√	√
Door	√	—
Roof	—	√
Walls	—	√
Floor	—	—

	Parts Labeled by Child	Parts Constructed by Child
Chimney	√	√
Door	√	√
Roof	√	√
Walls	√	√
Floor	—	—

Figure 1: Typical houses at two ages, with constructed and labeled parts

questions of the children. By asking children, "What have you made? Tell me about it," one can discover their understanding of train stations, farms, or houses. By asking questions such as, "Where is the door and the window?" one can challenge the child to consider parts that may not be shown in the construction, thereby giving new parts that can be added to the child's schemes for the whole. These questions can be used for any subject matter that the child may be dealing with, and they can also be used with materials other than blocks (such as clay, paint, or other manipulables).

One factor that may limit younger children's inclusion of parts in block constructions is their inability to create complex block configurations (Reifel & Greenfield, 1982; Greenfield, 1978). Younger children can create arches and enclosures, but they are less likely to be able to create closed enclosures with embedded arches, configurations that are necessary for duplicating the real-world complexity of a house. (This finding may reflect the skills of the children we studied; other children may have different skills.) Since younger children do not have the cognitive structures to create more complex configurations out of blocks, they cannot show the detailed relationships of parts (such as doors and walls) to the whole. They are more likely to produce symbols that do not show parts, such as a house that consists of one block. Older children, who have the cognitive structure to create complex configurations, do make use of their skills in the representation of parts and the whole.

There are many possible ways of assessing the growth of part-whole relations. Representational block play is one domain of behavior where the relationship of parts becomes physically present for our inspection. It remains to be seen how children demonstrate their part-whole understanding of referents other than houses. For example, blocks can represent cars, people, and many other things in pretend play. What parts do children differentiate when they represent these referents? How adequate are blocks for allowing the depiction of the parts of different referents? These are questions for further research.

Related to these questions is the comparability of block representations to other forms of representation, such as drawing and painting. Clearly, blocks provide a dimension to representation of parts that is not available in two-dimensional depictions. How do block representations relate to representations in other media? Are some media more appropriate for showing parts than other media are? Research on the construction of part-whole relationships in diverse media will provide more tools for informal assessment of children's conceptual progress in the early childhood classroom.

Reference Note

1. Reifel, S. *Non-linguistic representation of a complex referent at two ages: Parallels and differences with language.* Paper presented at the NATO Conference on Acquisition of Symbolic Skills, University of Keele, England, July 1982.

References

Brown, A.L. Recognition, reconstruction, and recall of narrative sequences by preoperational children. *Child Development,* 1975, *46,* 156-166.

Greenfield, P.M. Structural parallels between language and action in development. In A. Lock (Ed.), *Action, gesture and language: The emergence of language.* London: Academic Press, 1978.

Guanella, F. Block building activities of young children. *Archives of Psychology,* 1935, *174.*

Johnson, H. The art of block building. In E.S. Hirsch (Ed.), *The block book.* Washington, D.C.: National Association for the Education of Young Children, 1974.

Piaget, J. *Play, dreams and imitation in childhood.* New York: Norton, 1962.

Reifel, S. *The development of symbolic representation: The case of building blocks.* Paper read at the Annual Meeting of the American Educational Research Association, April, 1981, Los Angeles. (ERIC Document Reproduction Service No. ED 200 333.)

Reifel, S. The structure and content of early representational play: The case of building blocks. In S. Hill and B.J. Barnes (Eds.), *Young children and their families.* Lexington, Mass.: Lexington Books, 1982.

Reifel, S., & Greenfield, P.M. Structural development in a symbolic medium: The representational use of block constructions. In G. Forman (Ed.), *Action and thought: From sensorimotor schemes to symbolic operations.* New York: Academic Press, 1982.

Stein, N.L. How children understand stories: A developmental analysis. In L.G. Katz (Ed.), *Current topics in early childhood education* (Vol. 2). Norwood, N.J.: Ablex, 1979.