DOCUMENT RESUME

ED 342 460 | PS 019 949

AUTHOR	Blevins-Knabe, Belinda
TITLE	"One for You, One for Me": The Development of Correspondence as a Quantifier.
PUB DATE	May 91
NOTE	23p.; Paper presented at the Annual Meeting of the Jean Piaget Society (Philadelphia, PA, May 1991).
PUB TYPE	Speeches/Conference Papers (150) -- Reports - Research/Technical (143)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Cognitive Development; *Conservation (Concept); *Division; Mathematical Concepts; *Number Concepts; *Preschool Children; Preschool Education
IDENTIFIERS	*Correspondence Theory; Piagetian Research

ABSTRACT

A central component in the young child's construction of a number system is an understanding of correspondence. Although current research demonstrates that preschool children use correspondence in a variety of tasks, the nature of the relationship between the use of correspondence action patterns and the use of correspondence as a quantifier is still not understood. This paper reports on three studies of 4- to 5-year-olds that were designed to determine whether preschool children know that correspondence can be used to measure quantity. Children were given number conservation, addition and subtraction, and division tasks. Only the division task varied across the three studies. Children were asked to divide a clump of 11 cookies into 2 equal parts. Whole cookies were used in the first study, and wholes and halves were used in the second and third studies. In most cases, children used several strategies on a trial, and correspondence was one of them. Children rarely used counting on all trials. Performance on the addition and subtraction tasks suggested that young children can use correspondence effectively to make equivalence judgments. However, most children were not successful in making judgments based on the differences in absolute numerosity between the two arrays. Additional findings suggested that children's use of correspondence precedes their understanding that correspondence can be used to measure quantity. Eight statistical tables are included. Contains 6 references. (LB)

"One For You, One For Me": The Development of Correspondence as a Quantifier

Belinda Blevins-Knabe
University of Arkansas at Little Rock

Paper presented at the meeting of the Jean Piaget Society, Philadelphia, May 1991. Preparation of this article was supported in part by the Marie Wilson Howells Endowment.

"One For You, One For Me": The Development of Correspondence as a Quantifier

A central component in the young child's construction of a number system is an understanding of correspondence. Although current research demonstrates that preschool children use correspondence in a variety of tasks, we still do not understand the nature of the relationship between the use of correspondence action patterns and the use of correspondence as a quantifier. Therefore we lack a complete picture of how correspondence fits into the developing child's concept of how to measure quantity.

What criteria have to be met before we can say that children are using correspondence as a quantifier? According to Klahr (1984) a quantifier provides an internal representation of quantity that can be used to make judgments about numerical equivalence. This definition leads to three criteria for the use of correspondence as a quantifier. First, correspondence action patterns must be used to construct groups. Children may use the correspondence actions themselves or they may recognize that someone else is using or has used them. Second, correspondence must be chosen as an appropriate quantifier. Third, correspondence must be used to make the equivalence judgment. An accurate judgment about numerical equivalence involves the additional criterion of knowing how deviations in the correspondence procedure influence a judgment of equivalence.

In the series of three studies to be described today children's use of correspondence was examined in three different tasks which all involved making equivalence judgments using correspondence information. Two of the tasks remained the same across studies and systematic changes were made in the third task, thus children's performance was examined in connection with between and within task variations. The question these studies were designed to answer is: do preschool children know that correspondence can be used to measure quantity?

Four- and five-year-olds participated in each study (see Table 1 for mean ages). In all studies children were given number conservation, addition and subtraction, and division tasks. The number conservation task involved children giving both judgments and explanations about two groups of eight objects. The addition and subtraction task could be used to divide children into the primitive, qualitative, superqualitative, and quantitative levels (see Table 2). Both the conservation and addition and subtraction tasks involved children making relative numerosity judgments about correspondences produced by an experimenter.

Only the division task varied across the three studies. In each study children were given a clump of cookies and asked to divide the cookies equally between two cookie monsters. The type of cookie used varied across studies. In study 1 children were given whole cookies and in studies 2 and 3 the cookies were two sizes, wholes and halves. The major difference between studies 2 and 3 was the ease of dividing the whole cookies into halves and assembling the halves into wholes (it was easier to assemble the cookies into wholes in study 3). Division trials in all studies included the variables of large and small numerosity and odd and even numbers, and in studies 2 and 3 the additional variable of cookie size. The division task, in contrast to the conservation and addition and subtraction tasks, involved children themselves initiating the use of correspondence.

Study 3 also included an error detection task which was designed to examine the issue of whether children recognize a violation of the correspondence procedure. On the error detection task the experimenter showed the children Ernie, from Sesame Street, and said that Ernie was supposed to divide the cookies between two cookie monsters so they both had the same amount to eat. There were three error detection trials; Ernie divided 11 cookies equally using one-to-one correspondence, Ernie divided 11 cookies equally using a random division strategy, and Ernie divided 11 cookies unequally using a random strategy. On both of the trials on which Ernie divided the cookies randomly there were multiple violations of the correspondence procedure occurring at the beginning, middle, and end of the trial. Children were not allowed to count on these trials.

First I will discuss children's performance on the division task. Children were scored as correct when they divided the cookies equally. This meant in study 1 that in the odd number trials they had to leave one cookie off. As you can see in Table 3 and Figure 1 the small and large odd number trials were the most difficult for children. One of the reasons that children had difficulty on the odd number trials was because there was a remainder. Most children gave the remainder cookie to one of the cookie monsters. Was their failure to construct two equal groups a function of the fact that the cookies could not be split? In study 2 half and whole cookies were provided in order to answer this question. As you can see in Table 4 and Figure 2 the use of whole and half cookies did not improve children's performance.

Perhaps children's performance did not improve in study 2 because the half cookies looked like 2 cookie pieces rather than one whole cookie. Therefore in study 3 the cookie design was changed so that they could be divided into halves or joined together to form wholes. Even with the change in design the odd number trials were more difficult for children (see Table 5 and Figure 3). Children's success in dividing the cookies was not significantly improved by changing the design of the cookies. This suggests that environmental support for the divisibility of the cookies was not as important an influence on children's performance as other factors such as numerosity, and an odd or even number of cookies.

The easiest trials in all studies were the small numerosity even number trials and the most difficult the large numerosity odd number trials. The methods children used to divide the cookies (described in Table 6) can provide information about why some types of trials were easier than others.

On the even number trials, both small and large numerosity, children most frequently used one of the correspondence strategies. With the exception of the 1 whole 2 half trials, on the odd number trials, both small and large numerosity, children used a variety of division strategies. In most cases children used several strategies on a trial and correspondence was one of them. Children's use of counting on all trials was infrequent.

It appears that children are more successful in dividing even numbers of cookies and that they use correspondence to do so. This pattern is consistent with the claim that children are using correspondence as a quantifier. But as Frydmann and Bryant (1988) have indicated, even number trials are not a good indicator of whether children are using correspondence as a quantifier. If children are using a repetitive strategy of alternating back and forth between two groups until all objects are distributed they will be successful on the even number trials. This will occur regardless of whether they are aware of how the procedure relates to their success. This procedure will not lead to success on the odd number trials because of the presence of a remainder. How children handle the remainder can indicate whether they are using correspondence as a quantifier. Children's difficulty with the odd number trials suggests that they are not using correspondence as a quantifier.

Further support for this claim comes from children's responses on the error detection task. Their judgments indicated that they were basing their decisions on factors other than whether Ernie had used a one-to-one correspondence procedure. Children's explanations shed some light on the reasons for their judgments. The most frequent explanations involved whether the two groups of cookies looked the same, or different, in number and whether a cookie was broken.

The results on the division task suggest that children may use correspondence actions (at least in some cases) before they understand the implications of these actions. This finding parallels the results of researchers studying counting who have found that children's use of counting precedes their understanding of counting principles (Briars & Siegler, 1984; Frye, Braisby. Lowe, Maroudas, & Nicholls, 1989).

How did children perform on the number conservation task? As can be seen in Table 7 very few children were classified as conservers. Children's performance on the conservation and division tasks is consistent in that the majority do not demonstrate an understanding of correspondence as a quantifier.

Children's performance on the addition and subtraction task allowed them to be classified into one of four reasoning levels. As can be seen in Table 8 most children were in the qualitative level, although several were classified into one of the top addition and subtraction levels. All children who were classified as conservers, using a judgment plus explanation criteria, were classified into the qualitative level or higher on the addition and subtraction task. This finding is consistent with that of previous research. The only significant correlation between children's performance on the addition and subtraction and division tasks was in Study 1. On the 11 whole cookie trials, more quantitative than qualitative children were scored as successful ($\chi^2(1, N = 35) = 6.98, p < .05$).

In general, there were no strong connections between performance on the division task and the other tasks. So what can we say in response to the question posed in the introduction: how does correspondence fit into the developing child's concept of how to measure quantity?

We can claim that performance on the addition and subtraction task demonstrates that young children can use correspondence effectively to make equivalence judgments. All children were able to use the correspondence information provided by the experimenter to make relative numerosity judgments. However, since few children were in the superqualitative or quantitative levels this indicates that most of them were not successful in making judgments based on the differences in absolute numerosity between two arrays. This suggests that there are some limits on their use of correspondence information. These limits may be related to how children represent the relevant information. Both Cooper (1991) and I (1991) :ave found that by 5 children's performance improves on the addition and subtraction task if they are given absolute numerosity information. Cooper (1991) has suggested that this effect occurs because the selection of the appropriate quantifier has been made for the child.

There is a range of possible quantifier strategies on the conservation and division tasks. Children can use correspondence and/or estimation to make conservation judgments and correspondence, estimation, or counting to make judgments on the division task. The choice of an accurate quantifier depends on both possessing the quantifier and understanding it. Successful choice of a quantifier may require a deeper and more elaborated knowledge, or in Piagetian terms--reflective abstraction, than actually using the quantifier. Of the components that were mentioned in the introduction as necessary for using correspondence as a quantifier: using correspondence action patterns to construct groups, choosing correspondence as an appropriate quantifier, using correspondence to make the equivalence judgment, and knowing how deviations in the correspondence procedure influence a judgment of equivalence; choosing correspondence as an appropriate quantifier and knowing how deviations in the correspondence procedure influence a judgment of equivalence are the two which would require reflective abstraction. These are the two components that children's performance on the odd number division trials suggest are lacking.

In conclusion, the diverse performance within and across these tasks suggests that children can use correspondence actions in solving number problems, but that their use of correspondence precedes an understanding that correspondence can be used to measure quantity.

References

Blevins-Knabe, B. (1991, April). Does counting help preschool children solve number problems? Paper presented at the meeting of the Society for Research in Child Development, Seattle, WA.

Briars, D. & Siegler, R. (1984). A featural analysis of preschoolers' counting knowledge. Developmental Psychology, 20, 607-618.

Cooper, R. (1991, April). The complementary roles of operator skills and strategy selection skills in early number development. Paper presented at the meeting of the Society for Research in Child Development, Seattle, WA.

Frye, D., Braisby, N., Lowe, J., Maroudas, C., & Nicholls, J. (1989). Young children's understanding of counting and cardinality. Child Development, 60, 1158-1171.

Frydman, O. & Bryant, P. (1988). Sharing and the understanding of number equivalence by young children. Cognitive Development, 3, 323-339.

Klahr, D. (1984). Transition processes in quantitative development. In R.J. Sternberg (Ed.), Mechanisms of cognitive development. (pp. 101-139). New York: W.H. Freeman.

Table 1

Mean Ages of Children in the Three Correspondence Studies

Study	N	Mean Age
1	20	4-6
	20	5-4
2	20	4-7
	20	5-4
3	20	4-5
	20	5-4

Table 1

Predicted Solutions to Trials by Addition and Subtraction Reasoning Levels

Trial Structure					Reasoning Level			
	Transformation*				Primitive	Qualitative	Superqualitative	Quantitative
Initial State	1st	2nd	3rd	Final State				
N**	+1			N + 1	correct	correct	correct	correct
N	+0			N				
N	+1			N + 1	N + 1 >	correct	correct	correct
N + 1	+0			N + 1	N + 1 + 0			
N	+1	+1		N + 2	N + 1 >	N + 1 =	correct	correct
N + 2	+0	+0		N + 2	N + 2 + 0	N + 2 + 0		
N	+1	+1	+1	N + 3	N + 1 >	N + 1 =	N + 1 + 1 =	correct
N + 3	+0	+0	+0	N + 3	N + 3 + 0	N + 3 + 0	N + 3 + 0	

*The subtraction trials were identical to the addition trials except that a subtraction of one occurred.

**N means that arrays are initially equal.

N

Table 3

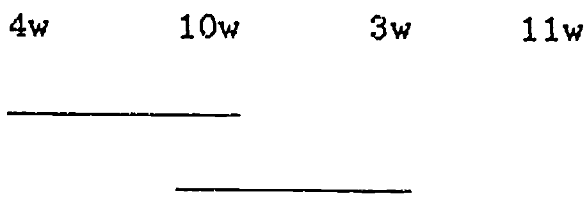
Mean Percent Correct on the Division Trials in Study 1

Age	3w*	4w	10w	11w
4	.65	1	.80	.30
5	.75	1	.90	.50

*w means whole cookie

Figure 1

Significant Differences Between the Division Trials in Study 1*



*Trials joined by a line are not significantly different, others differ using Tukey tests ($p < .05$).

Table 4

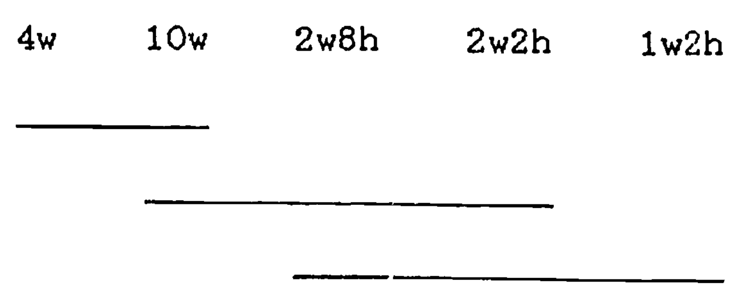
Mean Percent Correct on the Division Trials in Study 2

Age	4w	2w2h*	1w2h	2w8h	10w	3w8h
4	1	.85	.55	.85	.90	.25
5	1	.58	.79	.74	.90	.27

*w means whole cookie and h means half cookie

Figure 2

Significant Differences Between the Division Trials in Study 2*



*Trials joined by a line are not significantly different, others differ using Tukey tests ($p < .05$).

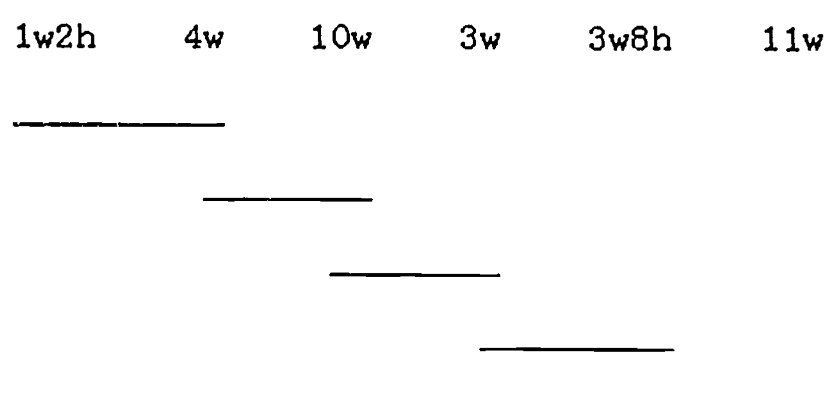
Table 5

Mean Percent Correct on the Division Trials in Study 3

Age	1w2h	3w	4w	10w	3w8h	11w
4	1	.63	.95	.66	.58	.41
5	1	.66	1	.80	.44	.33

Figure 3

Significant Differences Between the Division Trials in Study 3*



*Trials joined by a line are not significantly different, others differ using Tukey tests ($p < .05$).

Table 6

Description of Division Strategies

I. Correspondence

All types of correspondence could be either simultaneous or alternating. Simultaneous correspondence involved placing the cookies on the plates at approximately the same time and alternating correspondence involved placing cookie(s) on the plates at different times.

a. one-one correspondence--put one cookie or cookie half on a plate and its equivalent on the other plate.

b. one-one correspondence, number--put one cookie on a plate and one cookie half on the other plate.

c. many-many correspondence--put some cookies on one plate and their equivalent on the other plate

d. many-many correspondence, number--put some cookies on one plate and the same number of cookies on the other plate

II. Subtraction--remove one or more cookies from a plate

III. Counting--any form of counting

IV. Miscellaneous distribution--put some on one plate and then put a different number on the other plate

V. Transfer--move one or more cookies or cookie halves from one plate to the other

VI. Addition--put one or more cookies or cookie halves on one plate, but none on the other plate

---

Table 7

Number of Children Making Conservation Judgments in the Three Correspondence Studies

Study	Judgments Only Correct	Judgments and Explanations Correct
1	9	3
2	3	6
3	12	5

Table 8

Number of Children Classified in Each Addition and Subtraction Level in the Three Correspondence Studies

Study	Primitive	Qualitative	Superqualitative or Quantitative
1	5	21	14
2	4	26	10
3	3	24	13