J. Child Psychol. Psychiat. Vol. 25, No. 2, pp. 315-318, 1984.
Printed in Great Britain.

0021-9630/84 $3.00 + 0.00
Pergamon Press Ltd.

ASKING ONLY ONE QUESTION IN THE CONSERVATION EXPERIMENT

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INTRODUCTION

IT IS often claimed that young children do not understand the principle of the invariance of quantity. This conclusion is based on the results of the well-known conservation experiments by Piaget and Szeminska (1952) which apparently show that children below 7 or 8 yr often wrongly treat a perceptual change as a real one. Simply lengthening a row of counters or squashing balls of plasticine seems to change the child's judgements about their number or their volume.

One cannot be certain of this conclusion, however. As Donaldson (1978, 1982) has pointed out, the experimenter might unwittingly force children to produce wrong answers against their better judgement. One of the most powerful empirical demonstrations of the justice of Donaldson's criticism was provided by Rose and Blank (1974). They varied the traditional number conservation experiment slightly by asking one question rather than two. The usual procedure is first to show the child two identical rows of counters side-by-side and ask him whether they are the same in number (the answer almost invariably is 'yes') and then to lengthen or shorten one of the rows and ask the same question once again. Rose and Blank's variation was to drop the pre-transformation question and only to ask the child to compare the rows after the transformation—a manoeuvre which had a significant effect: children who failed the traditional task often succeeded when one question only was asked.

The result suggests that young children often fail the traditional task for a reason which is quite different to the one suggested by Piaget. Instead, the child may think that the experimenter asks the question the second time because he wants another answer. If this is so the child's error in the conservation task has nothing to do with the transformation (and therefore with the principle of invariance) but is simply a misinterpretation of what the experimenter wants to hear.

Thus the experiment is an extremely important one. But it is also limited: it deals only with number and it involves only one age group—6-yr-old children. We badly need to know whether younger and older children are affected in the same way by being asked one question only and also whether other versions of the conservation task will produce the same pattern of results.

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Accepted manuscript received 17 *January* 1983

METHOD

Subjects

In all 252 boys and girls between 5 and 8½ yrs took part in this experiment. They were all in schools and playgroups in and around Crediton, Devon. They were divided into 4 age groups of 63 children whose mean ages were 5 yr 3 months, 6 yr 3 months, 7 yr 3 months and 8 yr 3 months. Each group was divided into 3 subgroups which were closely matched in age.

Design and procedure

Subgroups and conditions. The groups were divided into 3 subgroups of 21 children of equal mean age, and each subgroup underwent a different condition. The three conditions were (1) standard: the traditional two question conservation task; (2) one judgement: the conservation task with only one question asked, and that after the transformation; and (3) fixed array control: where the child saw no transformation being given; all that was seen was the post-transformation display. A judgement was required about that. The purpose of this third condition was to check that children who answered the post-transformational question correctly in the other two conditions did so by bringing over information from the pre-transformation display.

Material. Three kinds of material were used in different trials. These were: (1) mass, in which conditions 1 and 2 the children were shown first two equal and identical Playdoh cylinders or two similar but unequal cylinder shapes, one longer than the other. The transformation was to squash one of these into a sausage or a pancake. After this the children were asked to compare the cylinder and the pancake (or the cylinder and sausage). The condition 3 children also made this comparison without seeing the first display or the transformation; (2) number, in which the children in conditions 1 and 2 were shown two rows of equal length arranged side-by-side in one-to-one correspondence. The rows contained either 6 and 6 counters or 6 and 5 counters. Then one row was spread out or bunched up. The condition 3 children saw only the post-transformation displays; and (3) volume, in which the children in conditions 1 and 2 were first shown two identical glasses either with the same or with different amounts of liquid. Then the liquid from one container was poured into a narrower one or a shallow wider one.

Trials. Each child was given four trials with each kind of material, two with equal and two with unequal quantities. The order of these trials and the order in which the three types of material were introduced were systematically varied between children.

RESULTS

We found no systematic difference between equal and unequal quantity trials and so we pooled the results for the two types of trial.

The results are presented in Tables 1 and 2. They demonstrate the reliability and the generality of Rose and Blank's experimental results. The one-judgement task (Rose and Blank's task) was typically easier than the standard conservation task and the fixed-array control. This appears to be generally true of all three types of material and of all four age levels. Table 1 shows that there are few exceptions to this general pattern and our statistics suggest these are chance variations.

We carried out a mixed design analysis of variance in which the main terms were age groups (5, 6, 7 and 8 yr), conditions (standard, one judgement, fixed array), and material (mass, number, volume); the last variable was a repeated measure. This analysis produced significant age differences (d.f. 3, 240, $F = 44.53$, $P < 0.001$), conditions differences (d.f. 2, 240, $F = 8.64$, $P < 0.001$) and materials differences (d.f. 2, 480, $F = 25.35$, $P < 0.001$). There were *no* significant interactions.

Subsequent Newman–Keuls tests demonstrated the following facts about these differences: (1) age: there was a significant difference between every age group and

TABLE 1. MEAN ERRORS (OUT OF 4) IN THE 3 CONDITIONS AND WITH THE 3 TYPES OF MATERIAL

Age (yr)	Material	Standard		One judgement		Fixed array	
	mass	2.762	(1.109)*	2.095	(1.444)	2.524	(0.906)
5	number	2.524	(1.622)	2.095	(1.540)	2.619	(1.463)
	volume	3.238	(1.191)	3.048	(1.290)	3.286	(0.825)
	mass	1.571	(1.247)	1.286	(1.350)	2.143	(1.082)
6	number	1.809	(1.468)	1.381	(1.759)	1.476	(1.367)
	volume	2.286	(1.694)	1.667	(1.522)	2.762	(1.230)
	mass	0.952	(1.430)	1.000	(1.414)	1.286	(0.983)
7	number	1.143	(1.424)	0.381	(0.844)	1.429	(1.620)
	volume	1.143	(1.582)	1.000	(1.414)	2.238	(1.151)
	mass	0.667	(1.321)	0.381	(0.844)	0.905	(0.868)
8	number	0.429	(0.791)	0.238	(0.610)	0.619	(0.844)
	volume	0.571	(1.218)	0.667	(1.321)	1.714	(1.314)

*The figures in parentheses are S.D.

TABLE 2. MEAN ERRORS SUMMED ACROSS MATERIALS (A) AND AGE (B)

	Standard		One judgement		Fixed array	
(A) The 3 conditions and 4 age groups summed across materials (mean errors out of 12)						
5 yr	8.524	(2.805)*	7,333	(3.427)	8.571	(2.083)
6 yr	5.714	(3.614)	4.333	(4.075)	6.381	(2.149)
7 yr	3.238	(3.766)	2.571	(3.646)	4.857	(2.965)
8 yr	1.667	(2.494)	1.333	(1.755)	3.333	(2.055)
(B) The 3 conditions and mass number and volume summed across age (mean errors out of 4)						
Mass	1.512	(1.516)	1.190	(1.427)	1.714	(1.160)
Number	1.476	(1.570	1.024	(1.488)	1.536	(1.531)
Volume	1.810	(1.769)	1.595	(1.663)	2.500	(1.286)

*Figures in parentheses are S.D.

the ordering was quite regular, the older groups doing consistently better than the younger; (2) conditions: the one-judgement task was significantly easier than the other two tasks (Rose and Blank's result). The standard task was also significantly easier than the fixed array task; and (3) materials: the number task was significantly easier than the mass and the volume tasks.

Thus despite overall differences in the skills of the four age groups and in the difficulty posed by the three types of material, Rose and Blank's result held good. Children who failed the traditional conservation task nevertheless succeeded more often when only one question was asked.

DISCUSSION

The consistent superiority of the one-question condition leads inexorably to one conclusion. Children who fail the traditional conservation task often do understand the principle of invariance and make their mistakes for a quite extraneous reason. They produce the wrong answer because the experimenter's repetition of the same question about the same material makes them think that they must change their answer the second time.

Any other explanation seems far fetched. The children must have been using their knowledge of invariance when they solved the one-judgement task because they did carry over information from the pre-transformation display, and to do so they must have realised that nothing had changed. We know that they did carry this information over because they did much better than the fixed-array children, who never saw the first display. All in all it does seem that the repetitive questioning of the traditional conservation experiment actively misleads the child.

Once again, as in many other cognitive experiments (Bryant, 1982a, b), we must conclude that the important question is not whether a child possesses an intellectual skill but how and when he decides to apply that skill. Young children, it seems, often do use the principles of invariance unless experimenters unwittingly persuade them not to.

SUMMARY

Rose and Blank have shown that 6-yr-old children do a great deal better in a conservation of number task if they are only asked to make a comparison after the transformation rather than both before and after seeing the quantity transformed. Our experiment shows that this important result applies as well to other materials (mass and volume) and to a wide age range (5–8 yr).

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