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ABSTRACT

IN ORDER TO STUDY THE INFLUENCE OF THE INFORMATION-PROCESSING STRATEGY OF AN ADULT MODEL ON THE SUBSEQUENT STRATEGY OF CHILDREN, 216 GRADE SCHOOL CHILDREN SOLVED MODIFIED TWENTY-QUESTIONS PROBLEMS. A REPEATED-MEASURES FACTORIAL DESIGN WAS USED WITH THE FOLLOWING VARIABLES: (1) INFORMATION-PROCESSING OF MODEL (HYPOTHESIS SCANNING, CONSTRAINT SEEKING, OR CONTROL), (2) STIMULUS DISPLAY (PICTORIAL OR VERBAL), (3) SCHOOL GRADE (THREE, FIVE, OR SEVEN), (4) SEX (MALE OR FEMALE), (5) PROBLEMS (2 PER SUBJECT). MAJOR RESULTS WERE: (1) FEWER QUESTIONS TO SOLUTION WITH THE CONSTRAINT-SEEKING MODEL THAN THE HYPOTHESIS-TESTING MODEL OR CONTROL, WHO DID NOT DIFFER, (2) BOTH A HIGHER PERCENTAGE OF CONSTRAINTS, AND HIGHER AVERAGE NUMBER OF ITEMS PER QUESTION WITH THE CONSTRAINT-SEEKING MODEL THAN THE CONTROL OF HYPOTHESIS-TESTING MODEL, AND WITH THE CONTROL THAN WITH THE HYPOTHESIS-TESTING MODEL, (3) BOTH A HIGHER PERCENTAGE OF CONSTRAINTS, AND HIGHER NUMBER OF ITEMS PER QUESTION, FOR SEVENTH THAN FIFTH AND THIRD GRADERS, AND FOR FIFTH THAN THIRD, (4) SIGNIFICANT MODEL BY GRADE INTERACTIONS FOR BOTH PERCENTAGE OF CONSTRAINTS AND ITEMS PER QUESTION, (5) NO EFFECTS FOR STIMULUS DISPLAY, SEX, OR SUCCESSIVE PROBLEMS ON ANY MEASURE. NOT AVAILABLE IN HARD COPY DUE TO MARGINAL LEGIBILITY OF ORIGINAL DOCUMENT . (AUTHOR)

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AN INVESTIGATION OF THE MANNER IN WHICH YOUNG CHILDREN PROCESS INTELLECTUAL INFORMATION

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Contents

Summary

In order to study the influence of the information-processing strategy of an adult model on the subsequent strategy of children, 216 grade school students solved modified twenty-questions problems. A 3 X 2 X 3 X 2 X 2 repeated-measures factorial design was used with the following variables: (1) information-processing of model (hypothesis scanning, constraint seeking, or control), (2) stimulus display (pictorial or verbal), (3) school grade (three, five, or seven), (4) sex (male or female), (5) problems (2 per S). Major results were: (1) fewer questions to solution with the constraint-seeking model than the hypothesis-testing model or control, who did not differ, (2) both a higher percentage of constraints, and higher average number of items included per question, with the constraint-seeking model than the control or hypothesis-testing model, and with the control than the hypothesis-testing model, (3) both a higher percentage of constraints, and higher number of items per question, for seventh than fifth and third graders, and for fifth than third, (4) significant model by grade interactions for both percentage of constraints and items per question, (5) no effects for stimulus display, sex, or successive problems on any measure.

Introduction

Bruner, Olver, and Greenfield (3) assume that the organization of a child's cognitive processes will be reflected in the questions he asks, and that the study of question asking is thus a method of externalizing the child's internal thought processes. In one of their experiments grade-school children played a modified game of "twenty questions" with the experimenter. The experimenter selected one object from an array of 42 drawings of common objects (e.g., a cow, sailboat, boy) and the child attempted to determine what object the experimenter had in mind by asking questions that could be answered by a "yes" or "no."

In this situation the authors distinguished two basic types of strategies or problem-solving methods used by the children: (1) hypothesis scanning, (2) constraint seeking. In hypothesis scanning the child asked a series of unrelated specific questions, e.g., "Is it the cow?" or "Is it the sailboat?" For a child who used the strategy of hypothesis scanning the number of questions necessary to solve the problem was determined purely by chance, and no underlying information processing demonstrated beyond the simple ability to formulate specific questions. In constraint seeking the child asked a question comprehensive enough to include at least two objects, e.g., "Is it red?" or "Is it larger than a dog?" and hence gained information from either a "yes" or "no" answer to his question. The strategy thus required an ability to perceive and categorize the objects in terms of subordination and superordination. In general, the use of constraint seeking relative to hypothesis scanning increased with age, and corresponded to a change from perceptual to functional, and from complexive to superordinate, bases of equivalence.

In a theoretical explanation of childrens' learning Bandura and Walters (1, 2, 4) have formulated a developmental theory in which the major concept is learning by imitation. Rather than the complicated processes of successive approximations and reinforcements postulated by most learning theories, the child learns by imitating the behavior of his formal and informal models. Thus, the purpose of the following experiment was to relate the approaches of Bruner et al. and Bandura and Walters in a study of the information-processing behavior of children who had previously observed an adult model solve the problems by using a strategy of hypothesis scanning or constraint seeking. In control conditions the adult model simply posed the problem to the child, but did not first solve a problem himself. Two types of stimulus displays were used, pictorial displays such as those of Bruner et al, and verbal displays, in which words replaced the corresponding drawings (e.g., the word "cow" replaced the drawing of a cow). The subjects were equal numbers of boys and girls in grades three, five, and seven.

Method

Design and Subjects. The experimental design was a 3 X 2 X 3 X 2 X 2 repeated-measures factorial with the following variables: (1) information-processing of model (hypothesis scanning, constraint seeking, or control), (2) stimulus display (pictorial or verbal), (3) school grade (three, five, or seven), (4) sex (male or female), (5) problems (two for each subject). The subjects were 216 children from four Chicago parochial grade schools. Six subjects were randomly assigned to each of the 36 experimental treatments.

Information Displays. The pictorial display was the same as used by Bruner et al (3), consisting of 42 drawings of common objects in a 6 X 7 matrix. The verbal display consisted of the lettered names of the same objects in the same arrangement. A smaller sample pictorial or verbal array consisting of 16 objects in a 4 X 4 matrix was used to demonstrate the problem during the initial instructions.

Procedure and Instructions. In all conditions the experimenter instructed the subject as follows:

> "Here is a board with 16 drawings (words). And here is a box with 16 pieces of paper, one for each of the drawings (words). First we will take one of the slips of paper, and then ask questions to decide which drawing (word) is on the piece of paper. You can ask any questions at all that I can answer by saying "yes" or "no." And you can have as many questions as you need, but try to find out the right answer in as few questions as you can. All right? Now take a piece of paper from the box, but don't look at it."

In hypothesis-scanning and constraint-seeking conditions the experimenter continued:

"First I am going to ask the questions to decide which drawing (word) is on the piece of paper. I'm going to show you one way to find out the answer, but you must remember that it is not the only way."

In hypothesis-scanning conditions the experimenter then asked a predetermined memorized random series of specific hypotheses (e.g., "Is it the dog?") until he solved the problem. Under constraint-seeking conditions he solved the problems as efficiently as possible by a series of constraints beginning from the standard constraint "Is it an animal?" After observing the experimenter solve the problem the subject then solved two problems selected by drawing pieces of paper from a new set of 42 pieces corresponding to the pictorial or verbal array. In control conditions the subject solved one problem from the sample 4 X 4 array and two from the full array. In all conditions the problem was solved when the subject asked the correct hypothesis. Four experimenters (two male and two female) each ran a proportionate number of subjects in all 36 conditions.

Results

Means for the 36 treatment groups for number of questions to solution, percentage of constraints, and average number of items included per question, for totals over the two problems on the full stimulus display, are given in Table 1. Results of analyses of variance on the three measures are given in Table 2. Since none of the main effects of successive problems or any of its interactions with other variables were significant, both Table 1 and Table 2 are for totals over the two problems only, omitting means and analyses of variance for successive problems.

<u>Number of Questions to Solution</u>. The effect of the model was significant, $F\ (2, 180) = 3.30$, $p < .05$. By Duncan multiple-range comparisons the constraint-seeking model resulted in fewer questions to solution than the control ($p < .01$) or hypothesis-scanning ($p < .001$) model, who did not differ. No other main effects or first-order interactions were significant.

<u>Percentage of Constraints</u>. Each question was scored as either a specific hypothesis or a constraint. The question was scored as a specific hypothesis if it referred to only one object (e.g., "Is it the cow?"), and as a constraint if it referred to at least two objects (e.g., "Is it an animal?"). Thus, by definition a constraint could not be the final solution to the problem. "Psuedoconstraints" (Bruner et al, 3), or questions phrased like a constraint but actually referring to only one object (e.g., "Does it have a sail?" when only one of the objects had a sail) were also scored, but their number was extremely small in all conditions, and hence they were not further analyzed. The number of constraint questions was then divided by the total number of questions on the problem to obtain the percentage of constraints. The effect of the model was significant, $F\ (2, 180) = 30.13$, $p < .001$. By Duncan comparisons there was a higher percentage of constraints with the constraint-seeking model than the control ($p < .001$) or the hypothesis-scanning ($p < .001$) model, and more for the control than the

Table 1

Mean Number of Questions to Solution, Percentage of Constraints, and Average Number of Items Included per Question, for Totals over Two Problems

Model	Display	Grade	Sex	Number of Questions	Percentage of Constraints	Items per Question
Hypothesis-Scanning	Pictorial	Three	Male	32.8	.20	2.60
			Female	16.3	.16	4.46
		Five	Male	26.8	.08	2.46
			Female	34.5	.11	4.02
		Seven	Male	28.8	.83	9.39
			Female	36.8	.32	5.32
	Verbal	Three	Male	60.7	.20	2.78
			Female	36.7	.19	2.83
		Five	Male	43.2	.11	2.77
			Female	24.5	.46	4.13
		Seven	Male	40.3	.24	3.72
			Female	45.0	.21	3.99
Constraint-Seeking	Pictorial	Three	Male	44.8	.61	5.44
			Female	43.0	.23	3.23
		Five	Male	24.8	1.17	8.68
			Female	24.2	1.03	9.33
		Seven	Male	27.7	1.04	6.58
			Female	17.7	.96	7.57
	Verbal	Three	Male	32.3	.36	3.32
			Female	31.7	.69	5.55
		Five	Male	24.7	1.06	8.90
			Female	34.0	.87	7.11
		Seven	Male	19.5	1.14	7.20
			Female	26.7	1.08	7.52
Control	Pictorial	Three	Male	36.5	.33	3.53
			Female	31.2	.41	3.76
		Five	Male	42.2	.61	7.17
			Female	30.7	.20	2.72
		Seven	Male	42.5	.54	4.89
			Female	39.7	.64	5.80
	Verbal	Three	Male	49.0	.45	5.82
			Female	40.0	.19	3.30
		Five	Male	21.2	.71	5.51
			Female	30.8	.41	4.01
		Seven	Male	31.8	.90	7.85
			Female	27.5	.79	7.57

Note: Maximum percentage of constraints is 2.00.

Table 2

Analyses of Variance for Number of Questions to Solution, Percentage of Constraints, and Average Number of Items Included per Constraint, for Totals over Two Problems

		Number of Questions		Percentage of Constraints		Items per Constraint	
Source	d.f.	MS	F	MS	F	MS	F
Model (M)	2	596	3.30*	3.20	30.13**	64.3	9.59**
Display (D)	1	36	< 1	.03	< 1	.8	< 1
Grade (G)	2	450	2.49	1.39	13.04**	61.1	9.10**
Sex (S)	1	482	2.67	.22	2.09	3.4	< 1
M X D	2	463	2.57	.07	< 1	12.6	1.88
M X G	4	238	1.32	.27	2.50*	16.4	2.44*
M X S	2	226	1.25	.03	< 1	5.7	< 1
D X G	2	308	1.70	.01	< 1	.5	< 1
D X S	1	52	< 1	.09	< 1	.6	< 1
G X S	2	227	1.26	.01	< 1	.9	< 1
M X D X G	4	526	2.91*	.17	1.63	8.5	1.27
M X D X S	2	157	< 1	.12	1.14	.7	< 1
M X G X S	4	212	1.17	.13	1.22	9.1	1.36
D X G X S	2	74	< 1	.00	< 1	.8	< 1
M X D X G X S	4	59	< 1	.11	1.01	11.4	1.71
Error (B)	180	181		.11		6.7	

*$p < .05$
**$p < .001$

Table 3

Correlations between Number of Questions, Percentage of Constraints, and Average Items per Question, for Totals over Two Problems, within Grade Levels and within Model Conditions

Grade	Number of Questions and Percentage of Constraints	Number of Questions and Average Items per Question	Percentage of Constraints and Average Items per Question
Three	.05 (.16)	-.14 (-.07)	.57 (.58)
Five	-.30 (-.29)	-.14 (.10)	.70 (.69)
Seven	-.74 (-.65)	-.48 (.17)	.75 (.67)
Total	-.33 (-.19)	-.28 (-.07)	.71 (.68)
Model			
Hypothesis	-.16 (.11)	-.30 (-.28)	.76 (.76)
Constraint	-.30 (-.12)	-.31 (-.14)	.71 (.68)
Control	-.39 (-.38)	-.16 (.11)	.61 (.60)

Note: Partial correlations with the third variable partialed out are given in parentheses.

hypothesis-scanning model ($p < .001$). The effect of grade was significant, $F(2, 180) = 13.04$, $p < .001$. Seventh graders had a higher percentage of constraints than fifth ($p < .01$) or third ($p < .001$) graders, and fifth more than third ($p < .001$).

The model-by-grade interaction was significant, $F(4, 180) = 2.50$, $p < .05$. The interaction was further analyzed in two ways by Duncan comparisons: (1) hypothesis-scanning versus constraint-seeking versus control within each grade level, (2) grades three versus five versus seven within each model level. For the third graders there was a higher percentage with the constraint-seeking model than the hypothesis-scanning model ($p < .01$), while neither the constraint-seeking nor hypothesis-scanning models differed from the control. For the fifth graders there was a higher percentage of constraints with the constraint-seeking model than the control ($p < .001$) or hypothesis-scanning model ($p < .001$), and more for the control than the hypothesis-scanning model ($p < .01$). The same pattern held for the seventh graders. For the hypothesis-scanning model seventh graders had a higher percentage of constraints than fifth ($p < .01$) or third ($p < .01$) graders, who did not differ. For the constraint-seeking model both seventh and fifth graders had a higher percentage of constraints than third graders ($p < .001$), but did not differ from each other. For the control conditions, seventh graders had a higher percentage of constraints than either fifth ($p < .05$) or third ($p < .001$) graders, who did not differ.

Thus, in summary, for the third graders the use of the more efficient strategy of constraint-seeking was neither increased by the constraint-seeking model nor decreased by the hypothesis-scanning model relative to the control, while for the fifth and seventh graders there was more use of the strategy with the constraint-seeking model and less with the hypothesis-scanning model relative to the control. Likewise, the seventh graders were better able to resist the influence of the hypothesis-scanning model than the fifth graders. Thus, the influence of the model in both facilitating and hindering the use of a more efficient strategy was most pronounced for the fifth graders.

Average Number of Items Included Per Question. This measure considered the number of items included in each question asked. A specific hypothesis included one item, while a constraint could include two or more. The total number of items included over all questions asked was divided by the number of questions to obtain the average number of items included per question. This measure was thus an index of the information value of each question, or alternatively, of the "quality" of the constraints. As indicated in Table 2, the results of analysis of variance for this measure corresponded exactly to those for the percentage of constraints. Also, the further Duncan comparisons corresponded exactly to those for the percentage of constraints, and hence they are not further reported. This correspondence of the two measures is also indicated by their high correlations in Table 3.

Correlations between Response Measures. The correlations between the three response measures are given in Table 3. Partial correlations with the third variable partialed out are given in parentheses after each correlation.

Discussion

The basic finding was the pronounced influence of observing the information-processing strategy employed by the adult model on the subsequent strategy employed by the child. Thus, observation of the constraint-seeking model resulted in a higher percentage of constraint questions than the controls who did not observe the model, and observation of the hypothesis-scanning model resulted in a lower percentage of constraints than the controls. Furthermore, children who observed the more efficient constraint-seeking strategy solved the problems in fewer questions than the controls, while those who observed the less efficient hypothesis-scanning strategy required more questions than the controls. This supports the emphasis of Bandura and Walters (1, 2, 4) upon the importance of the model in learning, and indicates that the model can both facilitate or hinder performance. Again, analyses of the significant model-by-grade interaction indicated that the influence of the model was relatively more important for the fifth graders than for the third or seventh graders. This interaction extends the expected result that the use of the constraint-seeking strategy increased directly with school grade. Finally, the influence of the model parallels and extends the finding of Bruner et al. that performance was better in "constraints conditions," in which their subjects were asked after each question whether or not they had sufficient information to solve the problem, than in "free conditions," in which nothing was said after each question.

The results for average number of items per question, which may be considered a measure of the information value of each question, or of the "quality" or comprehensiveness of each constraint, corresponded exactly to the results for the percentage of constraints. Thus, the dichotomous measure of a constraint versus a specific hypothesis for each question gave the same results as a more elaborate information analysis. In other words, the presence or absence of the ability to categorize objects into logical or functional groups and to use these groupings as a basis of constraint questions was as important as the specific type of constraint questions used. Finally, the nonsignificant difference between the pictorial and verbal displays indicates that this dichotomous presence or absence of the ability to use constraints was equally important in the more abstract displays of words and the more concrete displays of drawings.

References

(1) Bandura, A. "Vicarious processes: A case of no-trial learning." In L. Berkowitz (Ed.), *Advances in experimental social psychology*. Vol. 2. 1965. Pp. 3-55.

(2) Bandura, A., & Walters, R. W. *Social learning and personality development*. New York: Holt, Rinehart, & Winston, 1963.

(3) Bruner, J. S., Olver, R. R., & Greenfield, P. M. *Studies in cognitive growth*. New York: Wiley, 1966.

(4) Walters, R. H., & Parke, R. D. "Social motivation, dependency, and susceptibility to social influence." In L. Berkowitz (Ed.), *Advances in experimental social psychology*. Vol. 1. 1964. Pp. 231-276.