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ABSTRACT

TEN KINDERGARTEN AND 46 FIRST GRADE CHILDREN WERE GIVEN TWO-CHOICE OBJECT DISCRIMINATION PROBLEMS, DURING WHICH A PROMPT INDICATED THE POSITIVE (REWARDED) OBJECT, P. GUIDED BY THE PROMPT, ALL SS SUBJECTS DISPLACED P AND THEREFORE OBSERVED ONLY ITS REWARD VALUE; NO DIRECT OBSERVATION WAS MADE OF THE REWARD VALUE OF THE NEGATIVE (NONREWARDED) OBJECT, N. ON TEST TRIALS, A NEW OBJECT, X, WAS SUBSTITUTED FOR P AND PAIRED WITH N. THE PERFORMANCE OF BOTH GROUPS WAS SIGNIFICANTLY ABOVE CHANCE ON THESE X + N TEST TRIALS. CONTROL CONDITIONS AND CONFIRMING VERBAL DATA ALLOWED THE CONCLUSION THAT THESE SS SUBJECTS HAD LOGICALLY INFERRED THE NEGATIVE VALUE OF N WHILE DISPLACING ONLY P DURING PROMPTED TRIALS AND WERE THEREFORE APPROPRIATELY AVOIDING N ON THE TEST TRIAL. (AUTHOR)

Technical Report No. 50

LOGICAL INFERENCE IN DISCRIMINATION LEARNING OF YOUNG CHILDREN

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Report from the Rule Learning Project
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PREFACE

Within the broad Center goal of improving cognitive learning, personnel in Program 1—Conditions and Processes of Learning—conduct basic research in laboratories and schools to investigate processes involved in cognitive learning and the variables and conditions associated with efficient learning.

In this Technical Report, Professor Fletcher describes one study in his series on children's learning of cognitive rules. The processes of classification and logical inference in 4- to 7-year-old children were investigated with the finding that some of these children did demonstrate inferential reasoning. Used successfully, the task in this study provides a basis for further research on the processes of classification and inference and for development of more complex tasks.

Herbert J. Klausmeier
Director

ABSTRACT

10 kindergarten and 46 first-grade children were given 2-choice object discrimination problems during which a prompt indicated the positive (rewarded) object, P. Guided by the prompt, all Ss displaced P and therefore observed only its reward value; no direct observation was made of the reward value of the negative (nonrewarded) object, N. On test trials a new object, X, was substituted for P, and paired with N. The performance of both groups was significantly above chance on these X + N test trials. Control conditions and confirming verbal data allowed the conclusion that these Ss had logically inferred the negative value of N while displacing only P during prompted trials and were therefore appropriately avoiding N on the test trial.

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I
INTRODUCTION

A commendable example of an analysis of a particular subject matter into requisite cognitive processes is found in the report of a committee of the American Association for the Advancement of Science (1964). Specifically concerned with enumerating the cognitive processes involved in "scientific inquiry," this committee listed (among others) the fundamental processes of classification and inference. In order to classify correctly, a child must first observe the trait (backbone) which constitutes the basis of the classification (vertebrates) and then apply the classification rule. Logical inference (i.e., reasoning to a conclusion) also involves observation, but this report carefully distinguishes between the processes of observation and inference. The child observes tracks in the snow and then infers the existence of an animal.

In order to conduct systematic basic research on cognitive processes per se, it is generally most convenient to arrange the simplest task, or problem, which involves the particular process or processes. The present writers contend that both the processes of classification and inference can be investigated most readily with the familiar and tractable 2-choice discrimination learning problem.

It seems self-evident that a 2-choice discrimination task does represent the simplest form of classification learning. The child must merely learn that on the basis of his observation (reward or reinforcement) one stimulus belongs to category "A" and as a result of a different observation (nonreward or nonreinforcement) the other stimulus belongs to category "B". Not so obvious is the fact that logical inference can also be involved in this simple learning task. Consider the logical structure of such discrimination problems. One stimulus (P) is positive or correct; the other (N), by definition, must be negative or incorrect. The value of one stimulus, therefore, logically implies the value of the other. Thus, given that S knows this dichotomous structure of a discrimination problem, on each trial he can learn the value of both stimuli even though direct information is obtained concerning only one stimulus. More explicitly, S can observe the value of the chosen stimulus, and he can infer immediately the value of the unchosen stimulus.

Unfortunately, conventional trial-and-error discrimination training procedures preclude a test of such inferential learning because over any series of trials S may directly observe the value of both stimuli, and the resulting performance is most parsimoniously attributed to "approach" and "avoidance" responses learned separately on each trial. In the present research a cue-substitution procedure is combined with a prompting technique which has been shown to effectively control the instrumental responses of children, retardates, and monkeys (Fletcher, 1966; Fletcher & Orr, 1967; Fletcher, Grogg, & Garske, in press). Essentially, during training trials instrumental responses are restricted to the P stimulus only. On a subsequent nonprompted test trial the P stimulus is replaced by a new stimulus (X) which is paired with the familiar N stimulus. Choice of the new X stimulus, then, indicates the extent to which S, while responding only to the P stimulus during training trials, also learned that the unchosen N stimulus was—by logical inference—incorrect. Using appropriate control conditions, this research attempts, therefore, to measure S's ability to learn inferentially about the unchosen member of a 2-choice discrimination pair. Stated differently, the question is whether young children can apply the logical rule, "if A, then not B."

II
EXPERIMENT I

METHOD

The $\underline{S}$s, 10 preschool children, 6 boys and 4 girls, 49 to 64 mos. (mean = 56.5), were volunteers from a local nursery school which functions primarily to care for children of working mothers. All $\underline{S}$s were test-naive, i.e., they had no known prior experience with discrimination learning experiments.

Apparatus

The apparatus consisted of an adjustable-height table supporting a detachable superstructure containing a one-way mirror, a stationary problem tray, and two independently operated curved screens, one opaque and one transparent (see Fletcher and Orr, 1967). Each screen, a one-quarter segment of a cylinder, rotated on a fixed point below the mirror. When both screens were in their forward (lowered) positions, the tray was accessible to $\underline{E}$ from the rear. When the inside opaque screen was rotated back, the problem tray was visually exposed to $\underline{S}$, but the transparent screen prevented his touching the stimuli; rotation of the clear screen permitted $\underline{S}$ to displace an object and retrieve a reward exposed in a foodwell located under each object.

The opaque white acrylic plastic problem tray contained two foodwells 10 in. apart. The front of the tray was 2 in. high, angled 45° from horizontal, and contained two 1 in. jeweled amber lights (prompts) directly in front of the foodwells.

Test stimuli were multidimensional junk objects. Brightly colored wooden, plastic, rubber, and metal items were reduced to random pieces which were then randomly combined on irregularly shaped wooden bases previously colored with blotches of spray paint. These stimuli are best described, then, as "nonsense" junk objects.

Procedure

Because $\underline{S}$s were test-naive, the first session was designed to establish the essence of a discrimination problem, i.e., that only one of two objects is "correct," and to show that the prompt consistently indicates which of the two stimuli is correct.

Each $\underline{S}$ was seated in front of the apparatus and told essentially that he would play a game in which he should try to find the reward (sugared cereal) which he could eat or save in the provided paper cup. On the first trial $\underline{S}$ was shown the problem tray with identical 4 x 4 x 1 in. grey blocks located behind each of the two foodwells. A reward was then placed in one of the foodwells and covered, and $\underline{S}$ was asked to push back the block in order to get the reward. On trial 2 a reward was similarly placed in one of the foodwells, but this time both blocks were pushed forward and a prompt was lighted in front of the baited (correct) grey block. Each $\underline{S}$ was then told that only one of the two blocks would be rewarded on any trial and that the prompt would always show which block is correct.

In order to assure their understanding of the significance of the prompt, $\underline{S}$s were then trained as follows. With the screens lowered the problem was arranged. Then the opaque screen was raised revealing the two identical grey blocks, the baited one indicated by the prompt, and $\underline{S}$s were told to "look." Two seconds later the transparent screen was rotated back allowing $\underline{S}$ to displace one of the blocks. All $\underline{S}$s were given series of eight trials until meeting a criterion of seven correct responses within one of the series. For these and all subsequent trials noncorrection procedures were enforced and rewarded position was randomized for each $\underline{S}$ independently.

After reaching the above criterion, $\underline{S}$s were tested immediately on 2-choice object discrimination problems. Each $\underline{S}$ was given four dis-

crimination problems each consisting of four prompted trials followed immediately by four nonprompted test trials. In transition from the grey block training phase Ss were told that the "game" would change in that "toys" or "objects" would be used instead of the grey blocks, but it was reiterated that the "light" would always indicate which one of the two objects was correct. This phase completed the first session.

On each of the next three daily test sessions five different 10–trial object discrimination problems were presented. The first five trials were prompted. Following these prompted trials, either the positive object (P) or the negative object (N) remained, its reward contingency maintained or reversed, while the other object was replaced by a novel object (X). These cue-substitution trials, consisting of five nonprompted conventional test trials, generate four distinct problems which, with the addition of a control problem, may be described completely as follows.

PX Problems: The previously positive object (P) remains, its reward contingency is maintained, and a novel object (X) replaces the old negative object (N).

XP Problems: The previously positive object remains, its reward contingency is switched (P becomes negative), and a novel object replaces the old negative object.

XN Problems: The previously negative object remains, its reward contingency is maintained, and a novel object replaces the old positive object.

NX Problems: The previously negative object remains, its reward contingency is switched (N becomes positive) and a novel object replaces the old positive object.

PN Problems: A control condition in which the same 2 objects and their respective reward contingencies continue.

Thus each problem began with the prompt lighted in front of P for five trials and continued for another five nonprompted test trials under one of the above arrangements. The order of the five problems was determined randomly for each S independently on each day, and three new objects were randomly chosen (without replacement) and designated P, N, or X for each problem.

RESULTS AND DISCUSSION

Performance on all initial prompted trials was virtually errorless; 99.9% of all responses were made to the prompted object, P. Thus it may be assumed that during the five prompted trials of each problem all Ss observed (and presumably learned) the reward value of P.

The question is whether or not the children also inferred the reward value of the unchosen object, N. The data most relevant to this question are found in the performance on the critical sixth trial of each problem (the first nonprompted choice which is not affected by subsequent intraproblem learning of reversed reward contingencies). With regard to these critical first test trials, there were obviously only three distinct problems presented daily: the one P + N, or control problem in which both familiar objects appear; the two P + X problems in which only the familiar P appears; and the two X + N problems in which only the old N object appears. The measure taken on all problems was not the number of "correct" responses but, rather, the number of "appropriate" responses. On P + N problems the appropriate response was to P, and on P + X problems it was also to P. But on X + N problems an appropriate response was to X if in fact S inferred the negative value of N while responding to P on the previous five prompted trials; otherwise chance performance was expected on the first test trial because S would not have observed the reward contingency of either X or N.

The percentages of appropriate responses on the critical sixth trial were 97, 88, and 83 for all P + N, P + X, and X + N problems respectively. A repeated measures analysis of variance on the percentage of correct Trial 6 responses revealed no significant effect of the three types of problems ($F = 2.75$; $df = 2/18$).

The crucial test, of course, is whether or not performance on the X + N problems was significantly above chance (50%). The observed 83% strongly suggests that Ss did indeed infer the reward value of N while observing only the reward value of P during the prompted trials. However, two possibly confounding effects militate against such a hasty conclusion. First, a "novelty" effect would produce above chance performance on X + N problems, i.e., a tendency to respond to the new or novel object, X, would result in an "appropriate" response in the absence of any inferentially learned avoidance of N. Second, over all problems the novel object was rewarded on a 50% reinforcement schedule. Thus an intermittent reinforcement effect, it could be argued, might also account for above chance performance on X + N problems by producing a net approach tendency to novel objects.

However, the difference between performance on the control P + N and the P + X problems should represent the extent to which Ss are seduced (for whatever reason) by the X object. In both of these problems the tendency to respond to the previously chosen P must be

identical. Therefore any observed decrement on the P + X problems can be used as an estimate of the tendency to choose novel objects.[1]

The results indicated a 9% decrement in performance (97%—88%), a decrement which can be attributed to a tendency to approach novel objects. Thus a conservative test of above chance performance on X + N problems requires first a 9% reduction in order to eliminate this possible confounding effect. A test revealed that the adjusted 74% appropriate responses on X + N problems was still significantly above chance ($t = 5.62$; $df = 9$; $p < .001$).

These results suggest, therefore, that given fairly extensive 2-choice discrimination training, preschool children easily learn the observed reward value of the chosen object and, to a reliable extent, they simultaneously infer the reward value of the unchosen object.

Of secondary importance are the transfer data from nonprompted test trials 7—10 of all problems. The percentages of correct responses on each type of problem were as follows: PN = 97; PX = 99; XP = 92; XN = 92; and NX = 91. Not surprisingly, an analysis of variance revealed a nonsignificant effect of Problem Type ($F = 2.36$; $df = 4/36$). These data suggest generally good transfer and they indicate the ease with which preschool children can make discrimination reversals.

[1]Although other arguments can be offered, only the present one seems to be viable in view of the results. For example, if one assumes a generalization effect (during training trials) which results in approach to N, then P + N represents a conflict trial, P + X should represent less of a conflict (and be associated with higher performance), and X + N test trial performance might be predicted to be less than chance. Similarly, if one assumes avoidance of novel objects, performance on P + X test trials should be highest, and performance on X + N should definitely be below chance—unless one concedes strong inferentially learned avoidance of N, precisely that which is being tested.

III
EXPERIMENT II

For two reasons first-grade children were observed in a simplified version of the same experiment. First, we assumed that far less discrimination training would be necessary to demonstrate logical inference by these older children. Second, we sought additional data which would confirm our interpretation that above chance performance on X + N problems indicated inferential learning and not some artifact of the cue-substitution procedure. To this end, we simply asked the subjects to explain their choice. A small pilot study with children about to enter first grade indicated that a respectable level of performance could be reached within one brief training session and that adequate explanations could be obtained. Thus, the following procedures were used.

METHOD

Subjects

The Ss were 46 first graders (28 male, 18 female) obtained from two classes within a local elementary school. All Ss were test-naive having had no known prior experience with E's, apparatus, procedures, or stimuli.

Apparatus

Two units, essentially identical to that used in Experiment I, were set up in an unused storage area of the school building. Multidimensional junk objects and cereal rewards were again used.

Procedure

Each S was seated in front of the apparatus, given a paper cup and examples of the rewards, and told that they would be playing a game in which they should attempt to win as many rewards as possible. On the first trial S was shown the presentation tray with identical grey blocks located behind each of the two foodwells. A reward was then placed in one of the foodwells, both were covered simultaneously, and a prompt was lighted in front of the baited grey block. The S was told that the "light" always indicated which of the two blocks was the "right" one, and he was asked to push back the prompted block to obtain the reward. Following a correct response in the presence of the prompt, S was asked to push back the remaining nonrewarded stimulus. It was emphasized verbally that the nonprompted object was always wrong and that only one block could be correct on any given trial. On Trial 2, with both screens lowered, one foodwell was baited and both were covered simultaneously with grey blocks. The opaque screen was raised, and S was instructed to look at both objects. The baited block was then "prompted," and it was reiterated that only one object could be correct, and that the prompt (light) would indicate which one was correct. Third and fourth trials were presented in the same manner. Each S was then given one object discrimination problem consisting of three prompted trials followed by seven nonprompted test trials. In transition from the preceding grey block phase, Ss were told the "game" would be altered in that "toys" or "objects" would henceforth be used, and it was emphasized that they should look at both the objects and that the light always indicated which of the two objects was correct. During the seven nonprompted test trials, Ss were told that now they would continue without the light and that they should simply try to find the reward. This pretraining was considered sufficient to establish the significance of the prompt and the rules for discrimination learning. During this and all subsequent training sugared cereals were used as rewards, noncorrection procedures were enforced, and rewarded position was randomized across trials for each S independently.

The test phase followed without interruption and consisted of prompted P + N trials followed by a single nonprompted test trial of the P + N, P + X, or X + N type as defined in Experiment I. For half the Ss two prompted trials preceded the single test trial; the remaining half received four prompted trials before the single test trial. A total of 18 problems were presented, six of each of the three types, and new objects were used for each problem. Within each series of 3 problems, the order of presentation (of the P + N, P + X, or X + N problems) was determined randomly for each S separately. The first five series (of the 3 problems) were considered training problems. On the sixth, or terminal, series each S was asked to verbalize his reason for making his particular choice on each of the three test trials.

Thus, object discrimination problems began with either two or four prompted P + N trials during which the prompt was lighted in front of P and S was allowed to displace one object and observe its reward value. A single nonprompted test trial followed and was one of three arrangements: P + N problems in which both previous objects appeared; P + X problems in which a new object (X) was substituted for the old N; and X + N problems in which the previously prompted P was replaced by a new object, X.

RESULTS AND DISCUSSION

Performance during all prompted trials was errorless, i.e., all Ss observed only the reward value of P. Clearly, all Ss understood the significance of the prompt, and one may assume that Ss learned the observed reward value of P during prompted trials.

As in Experiment I, the crucial question is whether learning was restricted to the displaced and rewarded P object during prompted trials or whether Ss in fact simultaneously inferred that the nondisplaced N object was nonrewarded. To answer this question, data from the terminal problem—the critical sixth series during which verbal responses were also recorded—were analyzed. The basic datum was therefore binomial, i.e., whether S was correct or incorrect, and these results, shown in Table 1, may be read either as the percentage of correct responses or the percentage of Ss responding correctly.

As revealed in Table 1, performance was generally better following four prompted trials than following two prompted trials. Moreover, confirming the results of Experiment I, performance was best on control P + N problems, next best on P + X problems, and lowest (but well above chance) on X + N problems.

Table 1

Percentages of Correct Choices on Nonprompted Test Trial of Terminal Problem Following Two Prompted Trials (Group I) or Four Prompted Trials (Group II)

	Type of Problem		
Group	P + N	P + X	X + N
I (n=23)	87	87	70
II (n=23)	96	87	78
I + II (n=46)	91	87	74

The number of correct responses on the crucial X + N problem was again corrected for a possible novelty effect (exactly as described in Experiment I), and for Groups I and II separately this corrected total was tested for a significant departure from chance performance (using the binomial approximation corrected for discontinuity). The resulting Z scores were both 1.67, significantly above chance ($p < .05$).

Perhaps the best summary information is the total number of correct responses made by both groups combined. These data, also shown in Table 1, may then be read as performance following an average of three prompted trials. These more stable data reveal a possible trivial 4% effect of novelty (i.e., the difference between performance on P + N and P + X problems). Performance on X + N problems, reduced by this 4%, was again reliably above chance ($Z = 2.51$; $p < .01$). It appears, therefore, that with only a minimum amount of instruction and experience concerning rules for 2–choice discrimination learning, first graders can reliably infer the reward value of the unchosen member of a discrimination pair.

A more detailed and informative analysis of overall performance may be made by considering whether S provided adequate or inadequate explanations for his choices on the terminal problems. An example of an "adequate" explanation for the P + N or P + X problem was "Because that one (P) was right before." For the X + N problem examples of adequate answers (i.e., ones which clearly reflected the necessary inference) were "Well, I knew that one (N) was wrong," or "Because it couldn't be that one (N)." Inadequate responses consisted of verbalizations which did not unambiguously indicate logical reasoning (e.g., "Because I thought it was right"—with no further explanation—and "I don't know") or nonverbal responses (e.g., shoulder shrugging and smiling) which indicated a reluctance to

explain. Table 2 contains the analysis of performance according to both the explanation and actual choice.

Table 2

Percentages of Subjects Making Adequate or Inadequate Explanations Following Correct or Incorrect Choices on the Terminal Problem

	Type of Problem		
Explanation - Choice	P + N	P + X	X + N
Adequate - Correct	48	52	17
Adequate - Incorrect	0	2	0
Inadequate - Correct	43	35	57
Inadequate - Incorrect	9	11	26

The data in row 1 of Table 2 clearly indicate that these children had less trouble justifying their repetitive choice of a previously chosen and rewarded object than they had explaining the avoidance of an object which by logical inference was nonrewarded on previous trials. However, 17% of these children unequivocally indicated that they had, in fact, inferred the nonrewarded value of N and were appropriately avoiding it on the test trials. Moreover, not a single explanation indicated a response to (or away from) novelty per se. These verbal data, therefore, amply justify the conclusion that above chance performance on the X + N trial does indeed reflect inferentially learned avoidance of N and not some artifact of the cue-substitution procedure.

The data in row 2 show that (except for a single aberrant S) when the children were able to verbalize adequately, their choice was consistent with their explanation. More interesting are the data which appear in the last two rows, i.e., the performance of Ss who did not provide adequate explanations for their choice. If, indeed, inadequate explanations accurately reflected inadequate understanding of the structure of discrimination problems, then by chance half of these Ss would guess correctly and half would guess incorrectly. But even a cursory examination of the data in the last two rows reveals the overwhelming tendency to choose the correct object despite the failure to justify the correct choice. Testing chance distribution of frequencies within these last two rows, chi-square values of 10.66, 5.76, 5.16 for P + N, P + X, and X + N problems, respectively, were all significant beyond the .05 level, forcing the conclusion that these children were not guessing. Thus the ability to explain either the repetitive choice of an observed rewarded stimulus or the avoidance of an inferred nonrewarded stimulus is a sufficient but not a necessary condition for correct performance by first graders.

IV
GENERAL DISCUSSION

These experiments demonstrate that the prompting technique effectively controls the instrumental response, that the cue-substitution procedure does not appear to introduce any serious novelty artifact, and that this modified discrimination learning procedure is therefore appropriate for studying the development of logical reasoning in young children.

The results convincingly indicate that 4- to 7-year-old children are capable of effectively utilizing the logical rule "if A, then not B." Specifically, given information concerning the state of one member of a pair, young children can and do logically infer the mutually exclusive state of the other member.

However, it is equally apparent that not all children demonstrate this inferential reasoning. Performance on the X + N problem was not particularly impressive (although statistically reliable). Furthermore, if this does indeed represent the simplest form of logical inference, then evidently this cognitive ability is far from fully developed in children of this age range. Before any definitive developmental statements can be made, further research is needed to enumerate the situational and organismic variables related to this form of inferential behavior.

The present research is obviously concerned with only a simple form of inferential behavior. Other researchers, particularly the Kendlers and their associates, have shown consistent interest in more complex forms of logical or inferential behavior of young children (Kendler & Kendler, 1956; Kendler, Kendler, Pliskoff, & D'Amato, 1958; Kendler & Kendler, 1961; Kendler & Kendler, 1962; Kendler, Kendler, & Carrick, 1966). Following Hull's example, these researchers have defined inferential behavior as the spontaneous integration of separate behavior segments in order to achieve a goal, and their general experimental paradigm essentially involved three tasks, two of which had to be combined sequentially for an adequate demonstration of inferential learning. Their research has shown the necessary linking of behavior segments—and, therefore, inferential behavior—by children solving a relatively complex task.

Clearly, therefore, inferential behavior can be defined so as to include a wide range of behaviors, and this behavior can be studied using many different experimental paradigms. It is our opinion, however, that future research concerned with the development of inferential behavior in children will profit most, not from continued research within a single experimental paradigm, but rather, from the development of a set of laboratory tasks hierarchically arranged according to the complexity of the inferential sequence needed for solution. A valid set of such tasks would provide the powerful techniques necessary for the arduous research relating organismic and situational factors to cognitive development. Moreover, each task or problem would, hopefully, suggest some practical training materials for use within the school to train the particular inferential behavior prior to the introduction of subject matter which requires that form of inference for solution of problems.

REFERENCES

American Association for the Advancement of Science. Science—a process approach. Commentary for Teachers. (2nd experimental edition) AAAS Miscellaneous Publication 64-16, 1964.

Fletcher, H. J. Discrimination learning by retardates as a function of number of implicit response trials. Psychonomic Science, 1966, 4, 159-160.

Fletcher, H. J., Grogg, T. M., & Garske, J. P. An analysis of ambiguous-cue problem performance of children, retardates and monkeys. Journal of Comparative and Physiological Psychology, 1968, in press.

Fletcher, H. J., & Orr, B. M. Instructions and observational learning in preschool children. Psychonomic Science, 1967, 7, 83-84.

Kendler, H. H., & Kendler, T. S. Inferential behavior in preschool children. Journal of Experimental Psychology, 1956, 51, 311-314.

Kendler, H. H., Kendler, T. S., Pliskoff, S. S., & D'Amato, M. F. Inferential behavior in children: I. The influence of reinforcement on incentive motivation. Journal of Experimental Psychology, 1958, 55, 207-212.

Kendler, T. S., & Kendler, H. H. Inferential behavior of children: II. The influence of order of presentation. Journal of Experimental Psychology, 1961, 61, 442-448.

Kendler, T. S., & Kendler, H. H. Inferential behavior of children as a function of age and subgoal constancy. Journal of Experimental Psychology, 1962, 64, 460-466.

Kendler, T. S., Kendler, H. H., & Carrick, M. A. Verbal labels and inferential problem solution of children. Child Development, 1966, 37, 749-763.