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Dimensional fixation with introtacts in kindergarten children

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The effects of introtact probes on the discrimination performance of kindergarten children were assessed in simultaneous discrimination tasks having size as the relevant dimension and both color and form as irrelevant dimensions varying within settings. With size as the relevant dimension, all of the children were trained against their initially preferred dimension (either color or form). Verbal hypotheses concerning the solution to the task (introtacts) were obtained prior to each choice response for half of the children. The children in the introtact condition performed more poorly than did those not required to give introtacts. The use of introtacts appeared to fixate the children's attention on the dimension named in their first introtact. The implications of the results for studies of hypothesis testing in young children are discussed.

Blank trials and introtacts have both been introduced in studies of discrimination learning and concept formation for purposes of monitoring the problem-solving strategies of children and adults (e.g., Gholson, Levine, & Phillips, 1972; Phillips & Levine, 1975; Spiker & Cantor, in press). With the blank-trial technique, standard learning trials with correct response feedback are separated by blocks of trials in which the subject receives no feedback following his choice responses. The pattern of responses made during each block of blank trials is then used to infer the strategy or response set being used by the subject. Introtacts are verbal hypotheses regarding solution to the task that are elicited from the subject either before or after the actual choice responses. Introtacts have been introduced in studies of hypothesis testing as a potential alternative to the more cumbersome, time-consuming, and potentially interfering blank-trial technique. The two techniques have been found to produce equivalent results in multidimensional discrimination tasks with adults (Karpf & Levine, 1971) and with sixth-grade children (Phillips, 1974), but not with children in second grade. Phillips found that second graders using introtacts were superior to those given blank trials in terms of the use of systematic problem-solving strategies. In addition, second graders in the introtact condition showed better discrimination performance than did control subjects who had neither introtacts nor blank trials. On the other hand, second graders receiving blank trials performed more poorly than did the controls. Phillips and Levine (1975) suggest that blank trials may produce the interference in younger children by increasing the memory load with respect to the results of preceding feedback trials.

Blank trials appear to have an even greater interference effect on kindergarten children. Gholson et al. (1972) report that kindergarten children given blank trials show stereotypic patterns of responding such as stimulus preference, position alternation, and position preference almost exclusively.

Since blank-trial probes interfere with the learning of younger children, introtacts are of particular importance as a potential alternative means of monitoring the learning process in these children. Spiker and Cantor (in press) used introtacts with kindergarten children to monitor changes in dimensional attention across trials. The introtact data were used to assess parameters required in theoretical prediction equations, with the result that nearly two-thirds of the total variability in discrimination performance was accounted for by the theory. Although the introtact data thus proved very useful with kindergarten children, Spiker and Cantor reported that they found it necessary to limit the use of introtacts to one probe per trial block, because more frequent use appeared to interfere with discrimination performance.

Since it would be highly desirable to use introtact probes on every trial with kindergarten children, the present study was conducted to investigate further the observations made by Spiker and Cantor during pilot work. In this experiment, two groups of kindergarten children received a two-choice simultaneous discrimination task with size as the relevant dimension and color and form as irrelevant dimensions, with both variable

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within trials. An introtact was obtained prior to the choice response on Trial 2 and on each succeeding trial for one group (introtact). The other group served as a control in which the only introtact was the one obtained prior to Trial 2 for purposes of determining initial dimensional preference. Since size was the relevant dimension in both groups, and since none of the children in either group named size as their initial introtact, all subjects were trained against their initial dimensional preference.

METHOD

Subjects

The subjects were 56 kindergarten children, 35 from the College Community School System in Cedar Rapids, Iowa, and 21 from the Iowa City Community School District. The mean chronological age was 72.9 months, with a range from 67 to 79 months. The children were randomly assigned in equal numbers to the control and introtact conditions. For half of the children in each of these major groups, large was the positive cue in the discrimination task; for the other half, small was the positive cue.

Stimuli

The stimuli were eight laminated plastic blocks varying in size (large and small), color (red and blue), and form (triangles and squares). The squares were 8.9 cm (large) and 6.4 cm (small) on a side, and the equilateral triangles were 10.6 cm (large) and 8.0 cm (small) on a side. Each block was halved along the horizontal plane and hinged on the back. Opening the block revealed a well that could be baited with a marble to indicate a correct choice.

The eight blocks were used to construct the two simultaneous problems, one with large as the positive cue and the other with small as the positive cue. Each problem had eight settings resulting from the orthogonal variation of all three dimensions within settings and the counterbalancing of the spatial position of the positive cue.

Apparatus

The apparatus was a modified Wisconsin General Testing Apparatus, painted gray. The blocks were presented on a sliding tray, with a vertical partition containing a one-way mirror separating the subject and the experimenter. The tray was retracted from the child's view while the experimenter placed and baited the blocks appropriately for the next trial. The blocks were placed on the tray and held in position with two magnets separated by 30 cm. A trial was initiated by pushing the tray forward, exposing the blocks to the subject. An overhead light together with a small incandescent lamp attached to the top of the partition provided constant illumination of the blocks. The subject indicated his choice by opening one of the blocks to look for the marble reward. Marbles obtained were saved in a metal container placed next to the apparatus.

Procedure

Each child was brought individually to a mobile laboratory immediately outside the school building for one 20- to 30-min experimental session. The child was introduced to the "learning game" and given the following instructions. "On each turn, two blocks will come out like this. Some of them are red, some are blue, some are big, some are little, some are squares, and some are triangles. One of the blocks has a marble inside. If you open the right one, you'll find the marble . . . . I always put the marble in the same kind of block. Try to remember which kind of block the marble is in. If you remember which kind of block the marble is in, you can find the marble every time." Before the blocks were presented for Trial 2, the experimenter obtained an initial introtact by saying, "Remember, some of the blocks are red, some are blue, and so forth. Which kind of block do you think always has the marble?" Children who named more than one dimensional value were asked, "Which *one* kind of block?" Before Trial 3, children in the introtact groups were further instructed, "When I say O.K. each time, you tell me which kind of block you think always has the marble." The introtact was obtained in these groups before each subsequent trial.

Learning trials were administered using a noncorrection procedure, with each of the eight settings being presented once in every block of eight trials. The criterion for learning was seven or eight correct choices in each of two successive blocks, with a minimum of 32 trials and a maximum of 48 trials.

RESULTS

The initial introtacts obtained for all children following Trial 1 revealed that one of the forms was named by 33 of the children, and one of the colors was named by the remaining 23 children. To the extent that the introtacts revealed initial dimensional preferences, all of the children were trained against their preference, since form and color were always irrelevant dimensions.

Discrimination performance in the control groups was superior to that in the introtact groups, both in terms of the proportions who met criterion and in terms of proportions of correct responses across trial blocks. In the control groups, the proportion who met criterion within 48 trials was $17/28 = .69$, whereas in the introtact groups, the proportion was only $8/28 = .29$. The difference between these proportions was significant [$\chi^2(1) = 5.85, p < .02$].

The mean proportions of correct responses across blocks of eight trials for the control and introtact conditions are presented in Table 1. For subjects who met criterion early, the score obtained in the second of their two criterial blocks was assigned to the remaining postcriterial blocks. An analysis of variance was performed on the proportions of correct responses, with trial blocks (1-6) as a within-subject factor and with condition (control or introtact) and positive cue (large or small) as between-subject factors. The difference between the means for the introtact condition (mean = .597) and the control condition (mean = .751) was significant [$F(1,52) = 8.89$, $p = .004$, $MSe = .226$]. The only other significant effect was for trial blocks [$F(5,260) = 10.85, p < .0001, MSe = .027$].

Table 1
Mean Proportion Correct Responses Across Trial Blocks For Control and Introtact Conditions

	Blocks of Eight Trials						Over-
Condition	1	2	3	4	5	6	all
Control	.612	.705	.763	.813	.804	.813	.751
Introtact	.504	.531	.585	.643	.656	.661	.597

DISCUSSION

The use of introtacts with kindergarten children in the present study clearly interfered with discrimination performance, thus substantiating the pilot observations reported by Spiker and Cantor (in press). It is important to note that all subjects were trained against their initial dimensional preference. Had the children been trained toward, rather than against, their initial preference, there seems little doubt that the introtacts would have facilitated performance. The fixation on the dimension initially named is clearly evident in the introtacts obtained. Of the 20 children in the introtact groups who did not meet criterion, 19 gave as introtacts only the two values on their initially preferred dimension in an apparently nonsystematic order for the remainder of the 48 trials. The only exception was a nonlearner who switched from form to color immediately after the first introtact, and then gave only color introtacts for the remaining trials. The tenacity of the dimensional fixation is particularly surprising in view of the unusually explicit set of instructions used. It will be recalled that all six dimensional values had been named twice by the experimenter, a practice that is quite uncommon in discrimination learning studies with children. Informal observations support the view that the fixation results from a narrowing of attention produced by the introtacts. Children who show fixation and who are subsequently asked by the experimenter to "see if one of the other kinds of blocks always has the marble" frequently do not appear to remember what other dimensional values are varying in the task and must be reminded by the experimenter. If, in fact, the fixation reflects a narrowing of attention, the use of introtacts may simply exaggerate a general tendency for children of this age to limit their attention to a single dimension. Even in the control groups, 39% of the children failed to solve the task, in which they were required to shift their attention away from the dimension named in their initial introtact.

The present results indicate that introtacts cannot be used to study problem-solving strategies in kindergarten children, without affecting their discrimination performance. Phillips (1974) found that introtacts also affected the discrimination performance of second graders, though she reported a facilitation effect rather than an interference effect. However, there are many important differences in the purpose and procedures in the two studies, in addition to the age difference. In particular, Phillips used a series of preliminary training problems, and then assessed performance in an additional series of short criterion-task problems. Thus, the children were pretrained in the use of introtacts during the solution of the preliminary problems. In the present study, the effects of introtacts were assessed during the acquisition of the first discrimination problem. Whether the introtacts would also produce dimensional fixation in second graders during original learning remains to be determined.

In addition to raising questions about the use of introtacts for studying problem-solving strategies in young children, the present study raises important questions about the nature of the observed dimensional fixation. Further investigation of this effect may provide basic information on the attentional processes of young children.

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