ANALYSIS AND MODIFICATION OF SEARCH STRATEGIES OF IMPULSIVE AND REFLECTIVE CHILDREN ON THE MATCHING FAMILIAR FIGURES TEST

TAMAR ZELNIKER, W. E. JEFFREY, RUTH AULT, and JACQUELYNNE PARSONS

University of California, Los Angeles

ZELNIKER, TAMAR; JEFFREY, W. E.; AULT, RUTH; and PARSONS, JACQUELYNNE. Analysis and Modification of Search Strategies of Impulsive and Reflective Children on the Matching Familiar Figures Test. CHILD DEVELOPMENT, 1972, 43, 321–335. *Eye movements of 9-year-old Ss designated as impulsive or reflective were recorded while the Ss were performing on three tasks: Task I—Matching Familiar Figures (MFF), Task II—Differentiating Familiar Figures (DFF), and Task III—a second set of MFF problems. The MFF task required the Ss to find the one variant that was identical with the standard, whereas on the DFF the Ss had to find the variant that was different from the standard. The eye-fixation data in Task II for both impulsive and reflective Ss showed a decrease in percentage of fixations on the standard and an increase in systematic comparisons of the variants. The modified scanning strategy found in Task II (DFF) transferred to Task III (MFF) problems for impulsives only; they made fewer errors in Task III than in Task I although their response latency was as short as their response latency in Task I. Data from a reaction-time (RT) task with variable preparatory intervals showed that with long preparatory intervals impulsive Ss had longer reaction times than reflective Ss, indicating the poorer ability of impulsive Ss to sustain attention.*

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Individual differences in performance on tasks that require a choice among several alternative responses have been identified by Kagan (1965a) as reflecting differences in conceptual tempo. Children who respond fast and make many errors are labeled "impulsive," whereas Ss who are slow to respond and make few errors are called "reflective." In general, reflective children have been found to perform better on visual-discrimination tasks, serial recall, inductive reasoning, and reading in the primary grades, than do those identified as impulsive (Kagan 1965b; Kagan, Pearson, & Welch 1966a).

Skills of the type mentioned are basic to adequate school performance. Therefore, if the impulsive child is to learn efficiently, either he or the mode of teaching must be altered. Several experiments have attempted to evaluate the influence of models on the performance of subjects on the Matching Familiar Figures test, a test that Kagan has used to identify impulsive and reflective children. In general, modeling (Debus 1970; Yando & Kagan 1968) as well as specific training to inhibit rapid responses (Kagan, Pearson, & Welch 1966b) has produced increased response latencies in the impulsive children, but with no corresponding decrease in error scores. This suggests that the difficulty may lie not in the speed of the response but possibly in the problem-solving strategy employed. If this were true, then training that provided impulsive children with an effective search strategy would be more helpful than training that only encouraged them to respond more slowly.

Vurpillot (1968) investigated visual-scanning strategies and their relationship to performance on a task that required Ss to determine whether two pictures containing multiple cues were the same or different. She found that 4- and 5-year-old Ss gave more "same" responses than 9-year-old Ss when the two stimuli were, in fact, different. Eye-movement data indicated that the young Ss' criterion for identity was based on finding no differences after comparing the two pictures on only a few of their components. The Matching Familiar Figures test requires the child to find from among six alternative stimuli the one that matches the standard. Thus, as in Vurpillot's study, if search is hasty, minor differences among variants are easily overlooked and there are frequent errors. An alternate procedure might well produce different results, however. For example, if a child were presented with five stimuli identical with the standard and only one that differed and were instructed to find the stimulus that differed, his search would end satisfactorily only upon finding a difference. Such a task might be expected to force the S to engage in a more thorough search and possibly to develop a more systematic strategy, which might, in turn, transfer to the Matching Familiar Figures test.

In order to determine (*a*) whether impulsive and reflective Ss did have different search strategies, (*b*) whether an alternate task might change that strategy, and (*c*) whether there is transfer of the strategy developed on the alternate task, visual fixations were recorded while children performed on both the Matching Familiar Figures test and the alternate task described above, which could be called the Discriminating Familiar Figures test.

It is also possible that, as Kagan, Moss, and Sigel (1963) suggest, poor performance on the Matching Familiar Figures test indicates that a child has difficulty sustaining attention to a task over a long period of time. In that case, changes in strategy will have little effect unless they in some way increase the child's interest in the task, thus sustaining his attention, or force a more effective strategy, which permits him to arrive at a correct solution within his usual span of attention.

An independent measure of attention span can be obtained by testing reaction time with a variable interval between a ready signal and stimulus onset, that is, a variable preparatory interval. If impulsive children are unable to sustain attention as long as reflective children, then impulsive children should do more poorly than reflective children following long preparatory intervals but not following short preparatory intervals. Therefore, all children were also tested on a variable preparatory-interval reaction-time task adopted from Grim (1967).

METHOD

Subjects.—The Ss were 40 third-grade children, 20 boys and 20 girls, from the University Elementary School at UCLA. Their ages ranged from 8-2 years to 9-6 years (mean age = 9-1 years).

Stimulus materials.—Thirty of Kagan's Matching Familiar Figures (MFF) problems were selected for the present study (Kagan 1964; Kagan, Rosman, Day, Albert, & Phillips 1964). The figures were line drawings of familiar objects such as airplanes, lamps, and clothing articles. Each problem included a standard figure and six variants mounted on a 15 × 30-inch white cardboard. Whereas the figures are usually arranged with the standard figure at the top and two rows of variants below, in this study the standard was mounted at the left center of the board and the comparison figures were arranged in two rows to the right of the standard, one row above and one below the standard. One of the six variants on each card was identical with the standard, and the remaining five differed from the standard, each in a unique detail. The variant identical with the standard appeared across problem cards an equal number of times in each of the six possible positions.

An item analysis of data obtained in a pilot study using 15 of the 30 MFF problems provided ratings of difficulty for each of the five different variants in each problem, as well as difficulty ratings of the 15 problems. The remaining 15 problems were rated for difficulty by three judges. The difficulty of a variant was determined by the number of times the variant was incorrectly selected by Ss as the one identical with the standard; the variant most often selected was rated most difficult, etc. Similarly, the

difficulty ratings of the problems were based on the average frequency with which incorrect variants were selected by Ss in each problem. Finally, each problem was assigned one of three levels of difficulty.

A second set of 30 problems included the same standard figures as the MFF set. However, only one of the six variants differed from the standard, while the remaining five were identical with the standard. This was called the Discriminating Familiar Figures (DFF) test. The variant with the highest rating of difficulty in an MFF problem was selected as the single different variant for the parallel DFF problem and was placed on the card in the position that the correct choice occupied in the corresponding MFF set. Two additional problems selected from Kagan's MFF cards were used as practice problems for each of the tests.

Apparatus.—A 40 × 40-inch white plywood board, with a 2½-inch hole in its center, stood 8 inches from the front edge of the table at an angle of 80 degrees with the table top. A stack of 10 problem cards was supported by small metal brackets attached 2 inches from the bottom of the board.

A Sony EV 200R videotape recorder and a Concord MTC 12 camera with an extension tube behind an 80-mm lens were used to record the Ss' eye movements. The camera was mounted behind the board, and the lens protruded through the hole in the middle of the board and the slot cut into the center of the cards. The slot, starting slightly to the left of center and going all the way to the right edge of the card, permitted the cards to be removed by sliding them to the left. A chin rest with forehead support was clasped to the front edge of the table on which the board was mounted. The chin rest, situated directly opposite the center of the board, could be adjusted for each S so that a S's left eye was on axis with the lens of the camera, 8 inches from the lens, and 10–12 inches from the board. Three small 7 w 110 v pilot lights were mounted on the board. Two of the lights were situated on the left and right sides ½ inch above the card and 10 inches apart. The third light was placed 3 inches to the right of the lens hole. The reflection of the lights on the S's pupil facilitated the scoring of the recorded eye movements. On a small monitor concealed from the S by the stimulus board, the E could observe the picture being recorded. Response latencies were timed with a stopwatch.

The apparatus used for the reaction-time test was placed in a second experimental room. This apparatus was contained in a cabinet 10 inches high, 14 inches wide, and 10 inches deep. A 1⅜-inch circular, frosted glass was centered 3 inches below the upper edge of the cabinet, and a lightly sprung response key was mounted on a base in front of the cabinet. The stimulus window was illuminated from inside the cabinet by 6.3 v bulbs behind either a red filter or a white diffuser. Screened from the S's view, two Hunter timers were wired to the lights in such a way that the white ready light remained on for one of five preselected preparatory intervals and was immediately followed by the red stimulus light. Each trial sequence was initiated by a foot switch that started the timers. A Hunter Klockounter measured reaction time in milliseconds. White noise was fed to earphones worn by each S. Setting the intensity such that normal conversation became barely audible sufficiently masked all auditory cues from the apparatus.

Design.—The Ss were randomly assigned to an experimental group or a control group with an equal number of boys and girls in each group. All Ss were presented with three tasks. For the experimental Ss the first task included 10 MFF problems; the second task, 10 DFF problems; and the third task, an additional 10 MFF problems. For the control Ss each task constituted a different set of 10 MFF problems.

To control for the different levels of difficulty of the different problems, E selected from the pool of 30 MFF problems a different set of problems for each S in each task. First, a set of 10 problems was selected for Task I; then 10 additional cards were chosen for Task III. For each control S the remaining 10 MFF problems were assigned to Task II, whereas for experimental Ss Task II included the DFF version of the remaining 10 problems. In order to counterbalance difficulty in every task, there were three problems from each of two difficulty levels and four problems from the third difficulty level. Thus, every S had the same number of problems from each difficulty level, and across Ss each task included the same number of problems from each level of difficulty. The cards were also selected such that for either group of Ss all problems occurred the same number of times in every task.

Procedure.—Each S was brought into the experimental room and seated in front of the board next to E. The E uncovered the MFF practice card and instructed S as follows: "Here is a picture of something you know [E pointed to the standard] and other pictures that look like it [E pointed to the variants]. You will have to point to one of these pictures that is just like this one [E pointed to standard] and say 'this one.' Let's do one for practice." The S proceeded to look for the correct variant and was helped by E if he had any difficulty. Following the practice trial, S was instructed to put his chin on the chin rest, which was then adjusted so that a clear picture of the S's left eye could be seen on a monitor visible to E but not to S. Then E attached a rubber band around the S's head and to each end of the forehead support. This prevented S from moving his head backward or sideways and thus decreasing the quality of the picture. The E then repeated the instructions, and S proceeded with the 10 problems of Task I. When S was correct, E said, "Fine," and removed that card to expose the next. If S was incorrect, E said, "No, that is not the right one. Try to find the one just like this one," and pointed to the standard. The E recorded each response until S got the item correct or until S made five errors, in which case S was shown the correct figure.

In Task II, the experimental Ss were presented with the DFF problems. Each S was shown the DFF practice card and was given the following instructions: "I am going to show you a picture of something you know and

other pictures that look like it. You will have to point to the one of these six pictures [E pointed to the variants] that differs from this one [E pointed to the standard]. Let's do one for practice." If S had any difficulty E helped him. Following the practice trial, E repeated the instructions and S proceeded with the 10 DFF problems. When S was correct, E said, "Good," and presented S with the next problem card. When S was wrong, E said, "Can you show me the difference? Try to find the picture that is different from this one," and pointed to the standard. The control Ss were given the second set of 10 MFF problems and therefore did not get different instructions. Task III consisted of 10 new MFF problems presented under Task I conditions.

The interval between the stimulus presentation and the S's first response (whether correct or incorrect) was recorded after every trial. The E recorded all responses on each trial as they occurred, and the movements of the S's left eye were videotaped.

When the three tasks were completed, S was taken to a second room and given the reaction-time (RT) test by another E. Each S was given the following instructions: "This is a reaction-time experiment. Inside the little window are two lights; one is white, the other red. When I say ready, you press this button [E pointed to the response key] and the white light will come on. When the white light changes to red, release the button as fast as you can."

Five practice trials were followed by 20 experimental trials. After the third practice trial, the headphones were put on S to mask any auditory cues.

The five preparatory intervals (PI) were 3, 5, 10, 15, and 20 sec. Each PI was presented once during the practice phase and four times during the 20 experimental trials. The PIs were arranged such that each PI was preceded only once by each of the other PIs. To control for possible order effects the last PI of the nth S was placed at the beginning of the sequence for the $n + 1$ S.

All impulsive and reflective Ss participated in a second RT session about 3–4 weeks following the completion of the experiment. In this session preparatory intervals were 10, 30, and 50 sec.

Classification.—The Ss were classified as impulsive or reflective on the basis of their performance on the initial 10 MFF problems (Task I). A double median split was employed in the classification. Impulsive Ss were those whose mean response latency fell below the median response latency of all Ss (29.0 sec) and whose mean error score fell above the median (9.5). Reflective Ss were those whose mean response latency fell above the median and whose mean error score fell below the median. The Ss whose scores fell on the median or for whom both mean latency and error score fell above or below the median were unclassified and excluded from further analysis. The classification yielded 15 reflective, 16 impulsive, and 9 unclassified Ss. The mean response latencies were 41.5 sec for reflectives, and 17.4 sec for impulsives. Mean error scores (for 10 trials) were 4.7 for reflectives and 14.0 for impulsives.

Eye-movements scoring.—The videotaped eye movements were shown on a 20-inch television monitor, and trials 2, 3, 9, and 10 of each task were scored by *E* and another judge. Neither judge knew the classification of the Ss. There were seven possible eye-fixation points, the six variants and the standard. The fixation points were numbered arbitrarily from 1 to 7. The judges viewed the tapes at approximately 30 frames per second, which was half the recording speed. While observing the monitor, *E* called off each fixation position by referring to its assigned number. The second judge observed the monitor and recorded the fixation positions in the order they were read. When the second judge disagreed with *E* on the position of a particular fixation, the trial was replayed. If, however, the two judges disagreed on the fixation position during the second viewing, the trial was played over once more and the tape slowed, if necessary, to one frame per second until the exact position of the fixation in question was determined. When the tape was viewed at such a slow speed, all disagreements were settled easily.

RESULTS

Response latency and error scores.—The mean error and response-latency scores for each of the groups in the three tasks are presented in figure 1. Because the reflective-impulsive classification was made on the basis of a double median split of error and response-latency scores on Task I, no comparisons were made between reflectives and impulsives on their Task I scores. Nevertheless, a Mann-Whitney *U* test was employed for a comparison of the experimental reflective and impulsive groups on Tasks

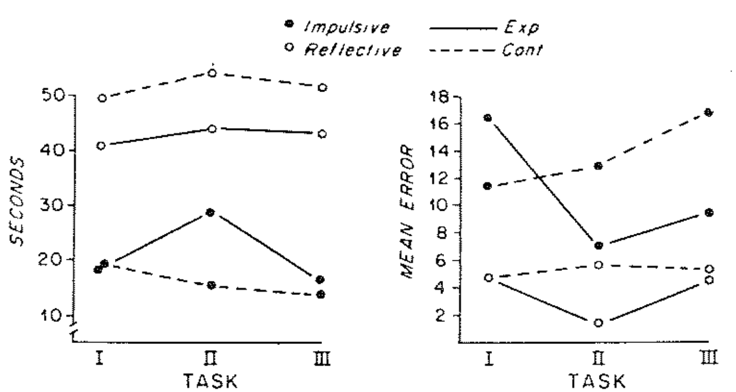

FIG. 1.—Mean error and response latency in seconds of the four groups on each task.

II and III and the experimental and control groups on all tasks. The relative error frequency and response latency of the two groups were maintained throughout the experiment; the experimental reflective Ss responded significantly more slowly than experimental impulsive Ss on Task II ($p < .05$) and on Task III ($p < .01$) and made significantly fewer errors than experimental impulsive Ss on Task II ($p < .05$) and on Task III ($p < .05$). The comparison between the experimental and control groups on response latency yielded only one significant difference; the experimental impulsive Ss responded more slowly than their controls on the DFF task ($p < .05$). However, when they returned to the MFF on Task III, their reaction time returned to a level comparable with that of the control Ss.

The within-groups comparisons also showed a significant decrease in error score from Task I to Tasks II and III for the experimental impulsive group ($p < .01$). It should be noted that even though the experimental impulsive group continued to make significantly more errors and responded significantly faster than the experimental reflective group on Tasks II and III, the experimental impulsive Ss made significantly fewer errors on these two tasks than they did on Task I.

Eye-fixation data.—Eye-fixation data were obtained by sampling four of the 10 trials for each task. When possible, these were trials 2, 3, 9, and 10; if any of these were not available, trial 4 or 8 was used. Four major measures of eye fixation were subjected to a split-plot $2 \times 2 \times 3$ factorial analysis of variance: mean number of fixations per trial, fixation duration (total time to the first response on sample trials divided by number of fixations for the four trials), proportion of fixations on the standard (number of fixations on the standard divided by the total number of fixations), and mean number of different variants fixated at least once during the trial (maximum was 6.0).

In order to compare the scanning strategy of impulsive and reflective Ss, their eye-movement scores (prior to the experimental manipulation) were compared. The impulsive and reflective Ss differed significantly only on two of the measures: the reflectives had more fixations ($p < .01$) and scanned more variants ($p < .01$) than the impulsives.

The mean numbers of eye fixations for each group on each task are plotted on figure 2. Reflective and impulsive Ss differed significantly in the average number of fixations, $F(1,27) = 44.5$, $p < .01$, and there was a significant difference attributable to tasks, $F(2,54) = 5.23$, $p < .01$. The only significant difference involving the fixation-duration data occurred between experimental and control groups, $F(1,27) = 5.69$, $p < .05$. Inasmuch as Ss were randomly assigned to groups prior to any measures being taken, this result is not of interest. As figure 3 indicates, the experimental groups were very similar in performance on the percentage of fixation they made on the standard, as were the two control groups. However, the experimental Ss reduced by nearly half the percentage of fixation on the standard in shift-

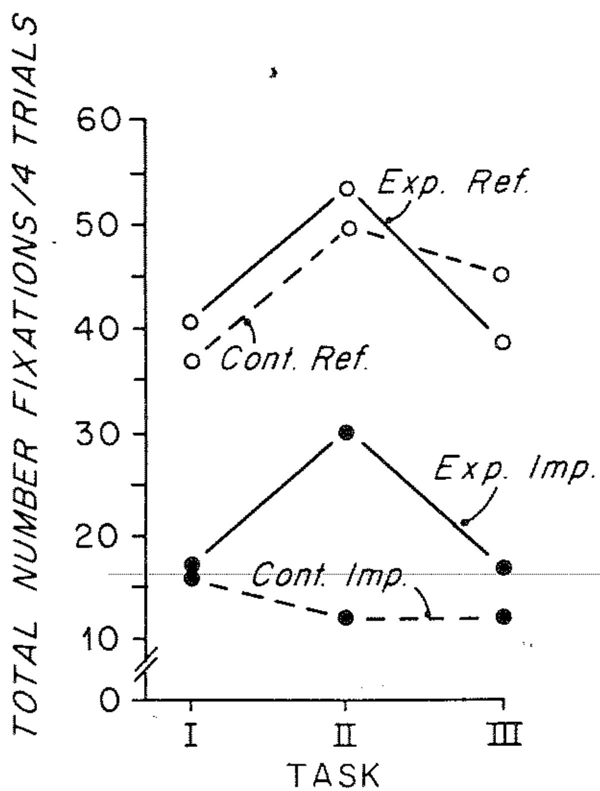

FIG. 2.—Mean number of fixations per problem of the four groups on each task.

ing from Task I to Task II. Experimental-control × tasks interaction gives an $F(2,54) = 22.90$ $p < .01$, and furthermore they did not recover to the Task I level on Task III. The experimental impulsives showed a significant decrease in the percentage of fixations on the standard from Task I to Task III ($p < .01$), while control Ss maintained a level around 30%–33%.

On Task I, reflective Ss scanned, on the average, over 5.5 out of the 6 possible different variants, while impulsive Ss averaged 4.5. This difference between groups is significant ($p < .01$). The effect of Task II is to increase significantly the number of variants scanned by the experimental impulsive Ss ($p < .01$; there is a ceiling for reflective Ss) and the increase is not completely lost on Task III although the difference was not quite significant ($.05 < p < .10$). At the same time, the impulsive control Ss continuously decreased in their efforts, from Task I to Task III ($p < .01$), so the triple interaction, experimental-control × reflective-impulsive × tasks, is signif-

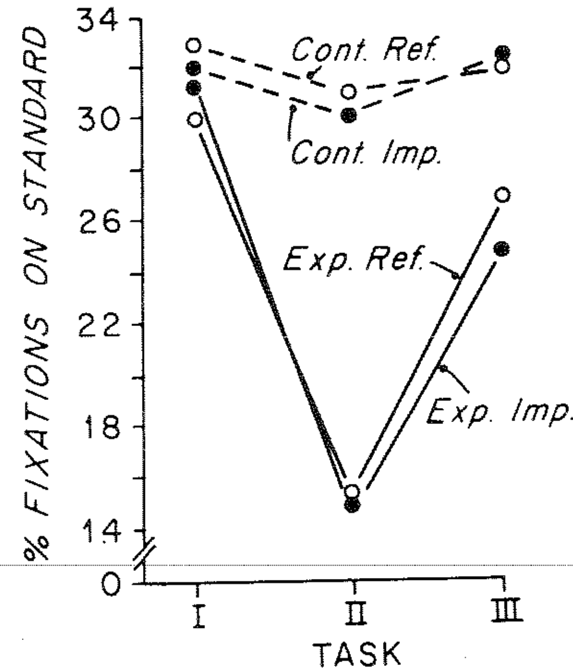

FIG. 3.—Percentage of fixations on the standard of the four groups on each task.

icant, $F(2,54) = 6.19$, $p < .05$, as are the three main effects and the treatment × tasks interaction, $F(2,54) = 5.0$, $p < .05$. Two scanning strategies were observed, and the incidence of each was scored. Each strategy consisted of a different pattern of successive fixations, one featuring paired comparisons labeled "returns" and the other featuring serial comparisons labeled "runs." A return was defined as any sequence of three fixations in which the first and third fixations were to the same stimulus. There were three types of returns possible: standard-variant$_1$-standard, variant$_1$-standard-variant$_1$, variant$_1$-variant$_2$-variant$_1$. The sequence std-v$_1$-std-v$_1$-v$_2$-v$_1$ contains three returns, one from each category. The percentage of all returns was obtained by adding the number of returns from each category, dividing by the total number of fixations, and multiplying by 100. These means are presented in figure 4. An analysis of variance of this measure revealed significant differences for all three main effects, experimental versus control, $F(1,27) = 11.89$, $p < .01$; reflective versus impulsive, $F(1,27) = 5.14$, $p < .05$; tasks, $F(2,54) = 12.96$, $p < .01$, and for the experimental-control × tasks interaction, $F(2,54) = 5.62$, $p < .05$. Because two of the three types of returns involve the standard, it was not surprising that in the experimental

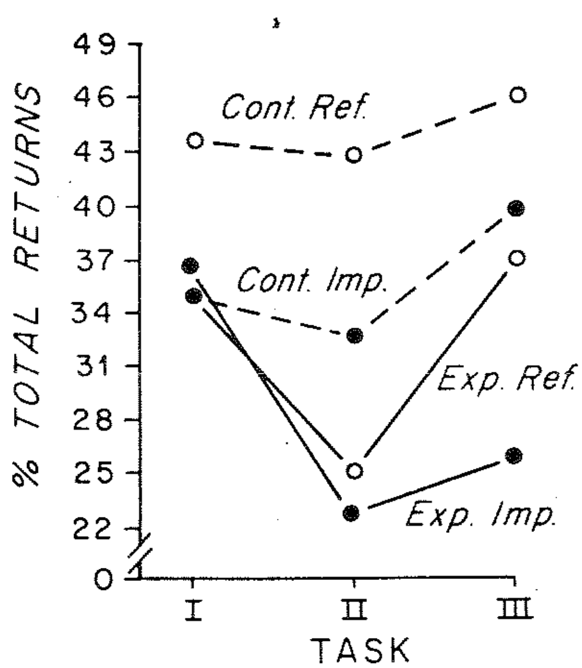

FIG. 4.—Percentage of total returns of the four groups on each task

groups the drop in percentage for all returns corresponded to the drop in percentage of fixations on the standard on Task II; moreover, a significant drop in number of returns from Task I was maintained by experimental impulsive Ss on Task III ($p < .01$).

The second kind of sequential data consisted of "runs" corresponding to the strategy where Ss pick one detail and check systematically all variants for it. Starting with the upper left variant, the variants were numbered clockwise from 1 to 6. A run was defined as the successive fixations of at least three different contiguous variants going either clockwise or counterclockwise but not both. Thus the sequence $v_1v_2v_3v_4v_5$ was scored as one run of extent 5. Similarly, $v_2v_1v_6v_5$ was one run of extent 4, and $v_1v_2v_3v_2v_1$ was two runs, each of extent 3 (and one return of the kind $v_2v_3v_2$). In order to give more weight to longer runs, the number of runs of extent 4 were multiplied by two, runs of extent 5 were multiplied by three and those of extent 6 were multiplied by four. The analysis of variance was performed both with and without the weighting factor, with essentially similar results. Significant differences for percentage of total weighted runs were found between experimental and control groups, $F(1,27) = 37.92$, $p < .01$, and the tasks, $F(2,54) = 40.83$, $p < .01$. The rise in percentage of runs for the experimental groups on Task II confirms that Ss changed search strategy for this

task and that the decrease in returns and regards at the standard was replaced by a systematic pattern rather than by random looking. The experimental impulsive Ss also maintained a higher percentage of runs in Task III than in Task I ($p < .01$).

Reaction-time test.—The reaction times (RT) were recorded in hundredths of a second and converted to logs for the purpose of analysis. The logs of the mean RTs obtained for each preparatory interval (PI) for each S were employed in a 2 × 5 (reflective-impulsive × PI) analysis of variance for the first reaction-time session and a 2 × 3 (reflective-impulsive × PI) for the second reaction-time session. In the first session, although the mean reaction time for the impulsive group was longer than for the reflective group, only the preparatory-interval effect was significant, $F(4,11) = 10.75$, $p < .01$. The results of the second session, however, showed that when longer preparatory intervals were employed, the reaction times of the impulsive Ss were significantly longer than the reaction times of the reflective Ss; the only significant effect then was attributable to the reflectivity-impulsivity dimension, $F(1,28) = 4.42$, $p < .05$.

DISCUSSION

As predicted, the experimental task did produce more effective problem-solving behavior in the impulsive Ss in that following the experimental task (DFF) they made fewer errors on Task III (MFF) than on Task I (MFF), whereas errors for the control impulsive group increased from Task I to Task III. It is particularly interesting that this improved performance by the experimental impulsive Ss was not accompanied by longer response latencies but rather by a change in search behavior.

The eye-fixation data proved to be very valuable in helping us to understand the changes that took place. Contrary to hypothesis, reflective and impulsive children did not differ in their scanning strategy on the *first task.* Given that reflective Ss spend more time at the task than impulsive Ss, the greater mean number of fixations and the greater mean number of variants fixated by reflectives appear to be direct correlates of the time S observes the card. Fixation duration and percentage of fixation on the standard, two measures that are not influenced by the longer response latency of the reflective Ss, do not differentiate these cognitive-style groups.

The results of this experiment are essentially in agreement with those obtained by Drake (1970). An analysis of the first 6 sec of each trial of Drake's data showed no significant differences between the reflective and impulsive Ss on any of the 10 eye-scanning response measures she analyzed. An analysis of total performance up to the first response on each card did show significant differences between reflectives and impulsives. However, the significantly larger number of fixations made by reflective Ss, as well as significant differences found for five additional measures not tested in the present study, were a function of the longer time the reflective Ss spend on each stimulus card.

Search behavior did change in the experimental task (DFF). In this task, all but one of the six variants are identical with the standard. Consequently, it was less essential to compare all variants with the standard in that any variant once identified as not being different from the standard served in place of the standard. The eye-fixation data indicate that both the impulsive and reflective children changed their scanning behavior, spending less time on the standard and more time on the variants. The performance of the impulsive Ss on Task III (MFF) following their experience with Task II (DFF) was more effective than their performance on Task I, although they spent just as short a period of time on both MFF tasks. Thus, it appears that spending more of that time making comparisons among variants rather than between variants and the standard is a more efficient strategy for both tasks.

The fact that number of variants scanned did not change significantly for the reflective Ss from Task I to Task II is due to a ceiling effect. They tended to scan all six variants on either task. On Task II, however, the experimental impulsive group scanned considerably more variants and the control impulsives fewer variants than on Task I. The decrement for the control impulsive group, who received a second set of MFF problems on Task II, is probably due to a general reduction in concentration on the task. Their performance deteriorated even further as they continued to Task III. The increase in number of variants scanned by the experimental impulsive Ss, as well as their longer response latencies when given Task II, may be explained in the following manner. On Task I Ss can conform to *E*'s instructions to find the variant that is the same as the standard by scanning a variant superficially and, upon not observing a difference, believe that it is identical with the standard. On the DFF task the same behavior does not meet *E*'s requirement that *S* find a difference. Thus, a hasty or incomplete search on Task II leaves S without an appropriate response, and S is forced to observe the variants more systematically.

It is not obvious why the impulsive Ss retained their different mode of search behavior acquired in Task II whereas the reflective Ss did not. It is possible that the higher level of success of the impulsive Ss on Task II increased their motivation to perform well on the tasks in general or at least made it more obvious that a correct solution was possible. The reflective Ss, on the other hand, were so successful on Task I that it was reasonable for them to revert to their previous strategy on returning to an MFF task. The fact that the experimental impulsive Ss returned to responding at the same speed as they had on Task I and the fact that previous experimental attempts to slow down the response latencies of impulsives have failed to improve performance suggest, however, that their ability to sustain attention may also be related to their poor performance. The poorer performance of impulsive

Ss on reaction-time tests with long preparatory intervals gives an independent indication of the inability of impulsive Ss to sustain attention. Impulsive Ss spent 18 sec on the average before responding on the MFF items. With preparatory intervals up to 20 sec the reaction performance of the impulsive Ss was not inferior to that of the reflective Ss, but with longer preparatory intervals the impulsive Ss performed significantly more poorly.

The inability to sustain attention is one of a number of behaviors that would be appropriate in a denotative definition of impulsivity. One can reasonably question whether there might be a constitutional difference between impulsive and reflective Ss that manifests itself in both the shorter attention span on the RT test and poorer MFF performance. Nevertheless, it is interesting to note that the ability to sustain attention interacted with the type of task used such that impulsive Ss took longer to respond and performed with greater accuracy on the DFF than on the MFF task. More important, however, is the fact that with a modification of the task, the impulsive Ss' scanning strategy was shown to be effectively modified, and the new strategy was retained and had a positive effect on performance on the MFF task even though their response latencies returned to their original levels. Thus, even if there were a constitutional component to impulsivity which was not alterable, there are ways to modify behavior in order to achieve better problem-solving performance. Thus we conclude that both task variables and individual differences deserve considerable attention in our attempts to understand the development of problem-solving skills in children.

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