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ABSTRACT

In an investigation of search strategies, it was predicted that reflective children would have developmentally more mature problem-solving strategies than impulsive children, and the presence of these strategies would be found in both 6- and 8-year-old subjects. From a sample given the Matching Familiar Figures Test, half of the 20 boys and 20 girls at each age level were classified as reflective and half as impulsive. Subjects were then administered a marble game task patterned after a 3-choice probability learning task. Strategies of guessing patterns were recorded. Analyses of the several possible task strategies substantiated the study's hypotheses with the 6-year-old sample, but not with the 8-year-old sample. The lack of significant findings with the older group was attributed to task inappropriateness for the 8-year level. (Author/MS)

STRATEGY DIFFERENCES BETWEEN REFLECTIVE AND IMPULSIVE CHILDREN[1]

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Considerable recent investigation of cognition has been centered on a construct known as conceptual tempo. Since this construct was initially proposed (Kagan, Rosman, Day, Albert, and Phillips, 1964), it has usually been thought of as a "tendency to reflect over alternative-solution possibilities, in contrast with the tendency to make an impulsive selection of a solution, in a problem of high response uncertainty" (Kagan, et al., 1964). Operationally, the construct of conceptual tempo has generally been defined by the degree of accuracy and length of decision time required in making a selection among several possible alternatives in a problem-solving task. Impulsivity refers to the tendency to make fast decisions and many errors, while reflectivity refers to slow decision times with relative accuracy. Using these criteria, the instrument principally used to index position on the dichotomous dimension is the Matching Familiar Figures Test (MFF). The MFF requires S to observe a standard figure and then select a figure exactly like the standard from an array of highly similar facsimiles. Latency to first response and number of incorrect selections are the usual variables recorded.

It has been shown (Kagan, 1966b) that children become increasingly more reflective as they get older. The assumption made in most all the

work in this area is that the process underlying tempo performance is the same from one age to another. There is the possibility, however, that the process(es) responsible for "reflective" behavior at one age level is (are) different from the process making for this kind of behavior at another age. Until most recently, little work has been done to investigate the process(es) which is (are) responsible for this response disposition. Using a problem solving task appropriate to assess search strategies, the author investigated two questions: (1) whether reflective and impulsive children are discriminated by their strategy differences at one age level, and (2) if these differences continue to discriminate between reflectives and impulsives at another age level. If differences were found it would be expected that reflective Ss would show more mature[3] problem-solving strategies (Siegelman, 1969; Drake, 1970).

METHOD

Subjects

Fifty six-year old ($\bar{X}$ = 73.8 months; s.d. = 3.4 months) and 52 eight-year old white children ($\bar{X}$ = 99.7 months; s.d. = 4.6 months) were given the MFF in order to obtain a sample of 20 impulsives and 20 reflectives at each age level. Reflectives and impulsives of each age group were composed of an equal number of boys and girls. Since I.Q. and MFF performance has not been found to be related, no control for intelligence was included, however, all Ss were of at least average intelligence. The children attended public elementary schools in a suburban community in central New York and were from neighborhoods generally consisting of middle class families.

Materials

The MFF and a marble game apparatus were employed. The administration of the MFF was the same as reported elsewhere (Kagan, et al., 1964). The mean response time was recorded to the nearest half-second by E using a stop watch. S's first response and the total number of errors for the 12 item test were the variables recorded. A double median-split criterion for each age group on errors and latencies defined the tempo groups.

The marble game apparatus was similar to that used by Weir (1964). It consisted of a rectangular panel on which was centered a row of three identical knobs. A signal light was mounted mid-line, 2 inches from the top of the panel. A delivery hole centered 7 inches from the bottom of the apparatus allowed marbles to fall into a small enclosed, clear-plastic container. S received a marble by pushing a knob forward.

Procedure

Each S had the MFF task administered to him. At the conclusion of the MFF, S was told that he had done a good job and would later get a chance to play with E's marble game. About a week following the MFF administration, the individuals selected for inclusion in the study were seen again by E and placed before the apparatus and told:

> Let me tell you how this game works. When the light comes on, you push one of the knobs. If you push the correct knob, a marble comes out here like this. If you push a wrong knob, no marble will come out. Now every time the light comes on, you push the knob that you think will get you a marble. Remember, just push the one knob you think is correct each

time the light comes on. Do you have any questions? Now try to get as many marbles as you can.

S was exposed to 80 trials at a 33% random reward schedule; that is, S was randomly rewarded only 33% of the time when he chose the knob which was randomly assigned as "correct" for him. (Choice of the rewarded knob will be referred to in the remainder of this manuscript as "correct" response, regardless of whether selection actually resulted in the delivery of a marble.) There was one exception to the random reward schedule; namely, all first choices of the correct knob were reinforced.

Four specific strategies were analyzed: perseveration, that is repeated choosing of the rewarded (correct) knob; patterned sequence guessing, that is selecting the right knob followed by the middle followed by the left knob (a RML pattern), or an initial selection of the left knob followed by the middle followed by the right knob (a LMR pattern); win-stay, which consisted of selecting the correct knob on trial n + 1 after selecting that knob having been rewarded on trial n; and finally lose-shift, consisting of choosing a different knob on trial n + 1 after choosing a knob and not getting rewarded on trial n.

Each younger S was also seen during a third session approximately two weeks following the marble task. This third session involved retesting on the MFF in an effort to establish reliability for the younger group. Significant reliabilities have already been reported for the older group (Kagan, 1965; Messer, 1968).

RESULTS

MFF Performance

It was found that the MFF was a suitably reliable instrument for this younger age group, at least for research purposes. Reliability coefficients ranged from .39 (female, errors) to .58 for both sexes combined on latencies. All coefficients were significant beyond the .05 level. An analysis of variance (ANOVA) showed no significant sex effects on MFF performance.

Marble Game Performance

The percent choice of the correct knob during trials 1-80 for young-impulsive (YI), young-reflective (YR), old-impulsive (OI) and old-reflective (OR) children is shown in Figure 1. A 2 (tempo) x 2 (sex) x 2 (age) x 8 (blocks of 10 trials) ANOVA yielded significant differences between reflective and impulsive Ss ($F = 5.80$; $df = 1, 72$; $p < .05$); the impulsive Ss made more correct responses ($\bar{X} = 4.51$) than reflective Ss ($\bar{X} = 3.92$). The significant age main effect ($F = 3.98$; $df = 1, 72$; $p < .05$) indicated that the younger Ss made more correct responses ($\bar{X} = 4.46$) than older Ss ($\bar{X} = 3.97$). A significant tempo x

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age interaction was found ($F = 8.21$; $df = 1, 72$; $p < .05$). Further analysis of the interaction components (Winer, 1962, p. 344) revealed that the YI group made more correct responses ($\bar{X} = 5.10$) than the YR ($\bar{X} = 3.81$), OI ($\bar{X} = 3.91$), and OR ($\bar{X} = 4.03$) groups. These latter three groups did not differ significantly from each other. There was no significant overall effect or interaction due to sex of S on this or any other analysis that follows.

Upon analyzing blocks 1-4 separately, the same main effects and interactions resulted as reported for blocks 1-8. Likewise, a separate analysis of correct responding in blocks 5-8 evidences similar findings, but in addition revealed a significant tempo x age x trials interaction ($F = 3.22$; $df = 3, 216$; $p < .05$). These results can be seen in Figure 1, where the OR Ss increase in correct responding toward the end of the task.

Insert Figure 1 about here

A tabulation of perseverative, correct response behavior showed that 20% of the YI Ss gave at least one sequence of 9 out of 10 correct responses over the 80 trials, compared to 5% of the YR Ss. A z test for percentage differences, described by Edwards (1960, p. 52), indicates the difference is significant at the .06 level ($z = 1.5$). No older Ss in either group gave a perseverative sequence of responses. A significant overall age effect was found ($z = 3.0$), with more younger Ss giving perseverative responses (16%) than older Ss (0%). When percent of repetition after the first reinforcement and nonreinforcement was calculated, it was found that 10% of the YR and 40% of the YI chose the

correct knob after being initially correct ($z = 2.2$; $p < .02$). Twenty percent of the OR Ss repeated the initially correct choice, compared to 50% of the OI Ss ($z = 2.0$; $p < .03$). There was no overall age effect and none of the children repeated their choice of an initially incorrect selection.

A 2 (tempo) x 2 (sex) x 2 (age) x 8 (blocks of trials) ANOVA on LMR and RML patterns revealed only a significant age x trials interaction ($F = 2.27$; $df = 7, 504$; $p < .05$) and is illustrated in Figure 2. It

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Insert Figure 2 about here.

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appears that for about the first half of the task, older Ss are using the LMR-RML pattern which is then used less consistently. The younger Ss begin with very little of LMR-RML pattern responding but rapidly increase their use of this pattern until the fourth block and then gradually increase the pattern response thereafter. Paired analysis of the means for the older Ss during the first ($\bar{X} = 6.10$) and last ($\bar{X} = 5.17$) 30 trials showed a significant decrease for the older Ss ($t = 1.92$; $df = 39$; $p < .05$), and the increase for the younger Ss from the first ($\bar{X} = 5.03$) and last ($\bar{X} = 6.18$) 30 trials also was found to be significant ($t = 2.22$; $df = 39$; $p < .025$).

When the RML-LMR data for blocks 1-4 were analyzed separately by a 2 x 2 x 2 x 4 ANOVA, only the age x trials interaction was significant ($F = 2.66$; $df = 3, 216$; $p < .05$). A similar analysis for blocks 5-8 revealed a significant age x tempo interaction ($F = 4.72$; $df = 1, 72$; $p < .05$) with YR Ss ($\bar{X} = 2.45$) giving more patterned responses than OR ($\bar{X} = 1.75$), YI ($\bar{X} = 1.60$), and OI ($\bar{X} = 1.85$) groups (Winer, 1962,

p. 344). The latter three groups did not significantly differ from each other.

The next analyses involved the win-stay/lose-shift strategies. Each subject's responses were tabulated so that it was known how many times S won/lost and shifted compared to his total number of win/losses for first and last halves of the trials. A block by block analysis was not utilized because of high nonstability of the number of wins/losses for any one block of trials. A 2 (tempo) x 2 (sex) x 2 (age) x (first and last halves of task) ANOVA of lose-shift responding showed a significant tempo effect ($F = 6.54$; $df = 1, 72$; $p < .05$), with reflectives evidencing more lose-shift behavior ($\bar{X} = 86.2\%$) than impulsives ($\bar{X} = 75.5\%$). There was a significant age x tempo interaction ($F = 4.68$; $df = 1, 72$; $p < .05$), for which further analysis showed YR Ss ($\bar{X} = 91.7\%$ to be no different from OI ($\bar{X} = 83.0\%$) and OR ($\bar{X} = 86.5\%$) Ss, but evidencing more lose-shift behavior than YI ($\bar{X} = 68.0\%$) Ss. In addition to these findings, a significant trials effect ($F = 15.56$; $df = 1, 72$; $p < .01$) revealed an overall decrease in lose-shift responding from the first half to the last half of the task.

Analysis of win-stay responding showed a significant tempo effect ($F = 10.26$; $df = 1, 72$; $p < .01$), a significant age effect ($F = 13.86$; $df = 1, 72$; $p < .01$) and a significant tempo x age interaction ($F = 9.68$; $df = 1, 72$; $p < .01$). Upon further analysis, the interaction revealed that YI Ss ($\bar{X} = 46.1\%$) gave more win-stay responses than YR ($\bar{X} = 17.4\%$), OI ($\bar{X} = 15.1\%$) and OR ($\bar{X} = 14.6\%$) groups, which did not significantly differ from each other.

In order to investigate the interrelatedness of marble game strategies as well as discover the strategies' relatedness to the MFF,

correlations were computed for each age group. MFF latency and error measures and each of the marble game dependent measures mentioned were correlated. For the younger Ss all the measures but one were significantly intercorrelated: (MFF latency and RML-LMR pattern responding). No marble task variable was found significantly related to the MFF measures for older children. These correlational findings are fully consistent with the ANOVA findings.

DISCUSSION

Theoretical considerations would suggest that reflective Ss would show developmentally more mature guessing strategies. In order to determine the maturity of guessing strategies of the young and old, reflective and impulsive subjects of this study, a comparison of these data was made with Weir's (1964) norms. When comparing reflective and impulsive Ss' percent of correct-choice responding over trials 60-80, it was found that young reflectives performed at a level similar to that of 7- to 9-year olds, whereas young impulsive Ss performed at a level similar to that of 5- and 7-year olds. For older Ss, reflective and impulsive Ss performed similarly to 7- and 9-year olds. Each age group combined performed at age levels similar to Weir's data.

When comparing RML-LMR pattern performance over all 80 trials, young and old performance was very similar to Weir's findings for these age groups. Young-reflective Ss, especially in the latter half of the task, showed performance quite atypical of any one of Weir's age groups. Young-reflective Ss began like young-impulsive Ss but, by 30 trials, began to respond at the level of the older Ss. After 30 trials, though, the older Ss began to give up this strategy, apparently finding it

non-productive. The young-reflective Ss, however, continued to use this strategy at an increasing rate on through to the end of the 80 trials. It seems that once the young-reflective Ss found a strategy, they could not evaluate its effectiveness. The young-impulsive Ss never utilized the RML-LMR patterning, at least until the very end of the task.

This problem-solving behavior of the young-reflective children seems to be similar to that described by Elkind (1968) as characteristic of concrete operational thinking in children 6-9 years of age. Using a Piagetian framework, Elkind characterizes a major component of concrete operational thought as the ability to generate hypotheses but not the ability to evaluate effectiveness in light of the evidence. In fact, Elkind's data suggest that the child may reinterpret the evidence to fit his hypothesis. It may be that this is what is occurring with the younger-reflective Ss. Once these Ss generate and implement the RML-LMR hypothesis, they do not relinquish it, despite its relative nonproductivity.

An alternative view of the young-reflective group's performance is that they could evaluate the effectiveness of the RML-LMR strategy, but because no alternative strategy was obviously apparent they maintained the patterning despite its relative nonproductivity. It is difficult to understand, though, why no other alternatives would be seen by the young-reflective Ss. Older Ss, produced RML-LMR patterns consistently less as the task progressed, and so apparently tried an alternative strategy. What these alternative strategies were could not be discerned and so were probably highly subject-specific.

The interaction between age and conceptual tempo was a consistently significant finding. At present, the most tenable explanation is that the marble task was too simple for the older children and did not allow much inter-subject variability. This view receives support if Weir's norms are examined. For example children between ages 5-7 differ by almost 20 percentage points in correct choices made. Between 7-9 years the difference is about 3 points. Therefore, tempo differences are not found on the marble task with the older Ss because variability is greatly constricted.

To test this position, a strategy task which generates substantial differences between 7- and 9-year old children should be employed. If the above explanation is correct, the tempo differences in older Ss should appear as they did for the younger children. If, after completing this research with a more demanding strategy task, no differences are again found with 8-year old Ss, an intriguing tempo x age interaction hypothesis would receive support and alternative theorizing would seem justified. That is, the idea that conceptual tempo may be genotypically distinct at different ages would receive support.

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FOOTNOTES

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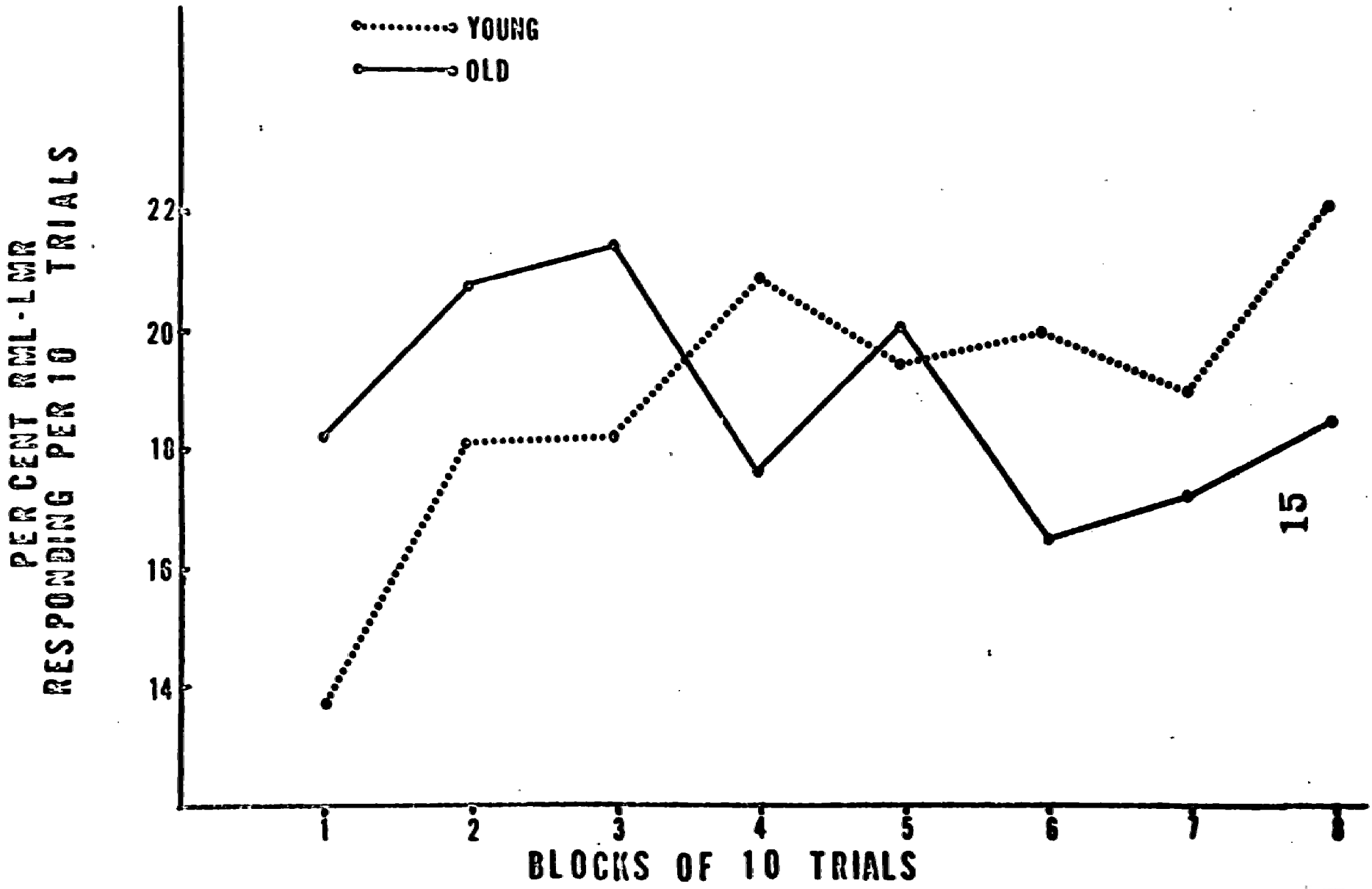
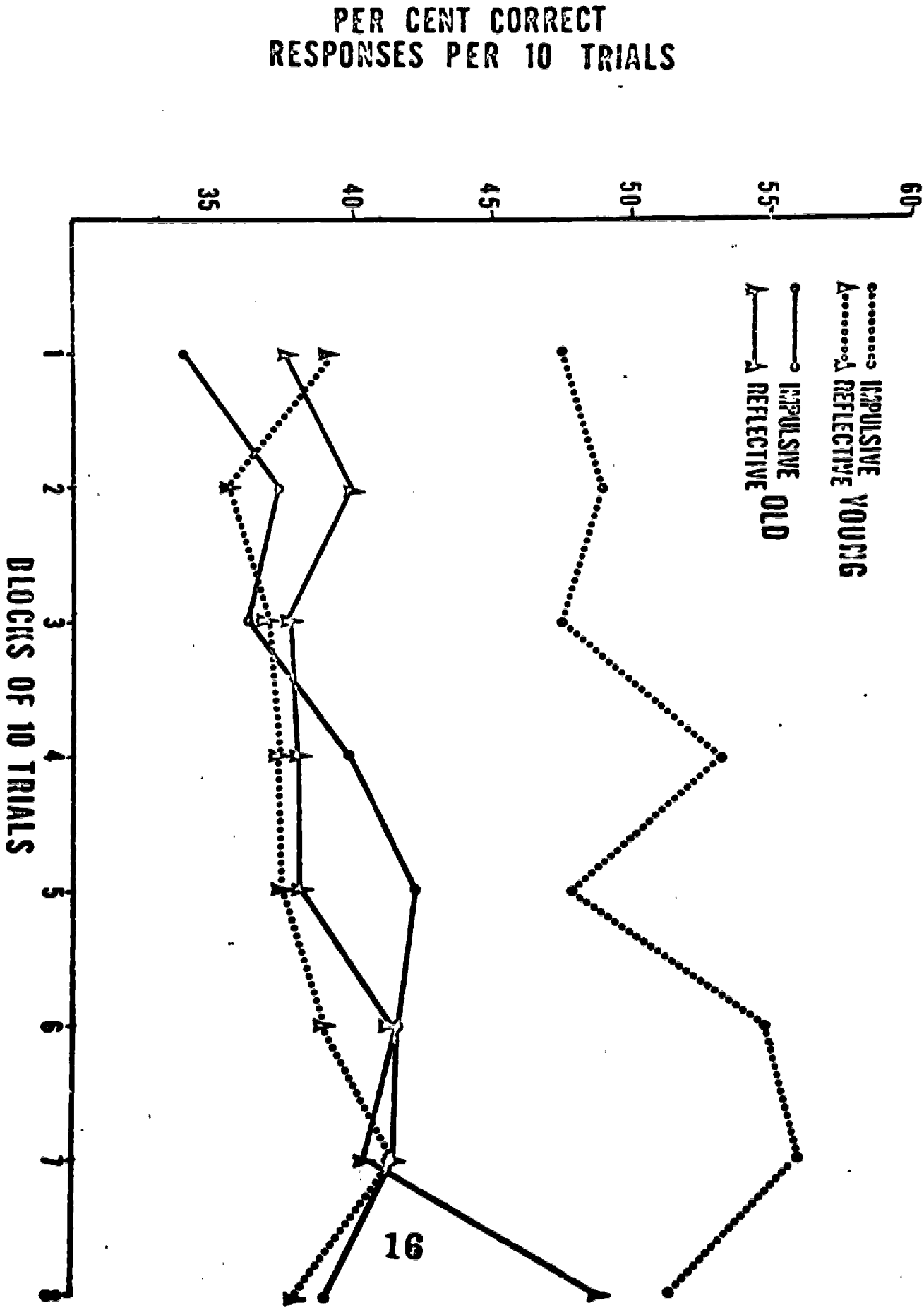
2. Request for reprints should be sent to Wayne V. Adams, Department of Psychology, Colgate University, Hamilton, New York 13346.

3. Maturity is used in an age-specific context throughout this manuscript, and refers to performance of subjects older than those under discussion.

Figure 1. Percent of correct responses as a function of blocks of 10 trials for reflective and impulsive, young and old subjects.

Figure 2. Old and young Ss' percent RML-LMR patterns per 10 trials as a function of blocks of trials.


YOUNG
OLD
PER CENT RML-LMR
RESPONDING PER 10 TRIALS
22
20
18
16
14
1
2
3
4
5
6
7
8
BLOCKS OF 10 TRIALS


PER CENT CORRECT
RESPONSES PER 10 TRIALS
60
55
50
45
40
35
IMPULSIVE
REFLECTIVE
YOUNG
IMPULSIVE
REFLECTIVE
OLD
1
2
3
4
5
6
7
8
BLOCKS OF 10 TRIALS