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ABSTRACT

The performance of college students on the adolescent-adult version of the Matching Familiar Figures (MFF) test was examined in three studies to determine the effects of strategies on performance. With the standard instructions for the MFF, performance was found to be unrelated to test anxiety or extraversion and was parallel in many respects to the performance of children on the equivalent form of the MFF. Instructions which emphasized accurate performance were effective in reducing errors and increasing latencies, but did not substantially alter the range of performances. Instructions which minimized feedback about performance and eliminated the most obvious cues for implicit strategies indicated that performance was more related to information processing style than to implicit strategies for performance. An alternative means of measuring performance on the MFF which attenuates performance differences that result from implicit strategies and allows for a more meaningful comparison of performances from different studies was proposed. (Author)

Style and Strategy in the Performance of the Adult Version of the Matching Familiar Figures Test

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Style and Strategy in the Performance of the Adult Version of the Matching Familiar Figures Test

The use of the Matching Familiar Figures (MFF) test to assess a dimension of cognitive style in children has become extremely widespread since its appearance more than a decade ago (Kagan, Rosman, Day, Albart, & Phillips, 1964). Messer (1976) offers an extensive review of the developmental literature concerning the MFF as a measure of impulsivity-reflectivity in children. The impulsive-reflective dimension can be characterized as the typical manner in which a child responds on a task when faced with a number of response alternatives, only one of which is correct. Children who respond quickly and with the high error rate are designated "impulsive," while those whose response latencies are longer and who respond accurately are designated "reflective." Much of the research and speculation on the nature of the relfective-impulsive dimension has focused on a search for personality and behavioral correlates of performance on the MFF, with relatively little focus on the nature of the test itself and the nature of the differences underlying the performance of children classified as impulsive or reflective.

Although Kagan (1966) has suggested that the underlying dimension in impulsivity-reflectivity may be constitutional, other res[illegible] h[illegible] ocused on other [illegible] re [illegible] onally determined [illegible] luencing performanc[illegible] [illegible] ones and McIntyre

(1976) have suggested that performance on the MFF in children may reflect differences in implicit speed-accuracy tradeoff strategies rather than differences in cognitive styles. A child may adopt a strategy (not explicit in the instructions) to quickly eliminate as many of the alternatives as possible and rely on feedback from the experimenter to direct the selection of alternatives. Such a strategy would allow for positive knowledge of results in a relatively short time. Jones and McIntyre state that there is no a priori reason to value one response strategy over another, although the implicit value in the labels "impulsive" and "reflective" is apparent both to the layman and in the literature.

A distinction between style and strategy is useful in conceptualizing performance differences on the MFF. Style is used here to mean an underlying individual difference in visual information processing (a term that includes scanning a stimulus array, processes involved in making visual comparisons, and reporting the results of those comparisons). It would be expected that a cognitive style is consistent for an individual, is consistent across a variety of tasks within an individual, is relatively impervious to short-term change, and is functional as a means of classifying individual differences. Strategy, on the other hand, refers to a method or plan for processing information that may come into play as the result of either implicit or explicit instructions. For example, a strategy for performance of the MFF may be adopted which consists of delaying responses until virtual certainty is achieved, thus minimizing errors. Alternatively, a strategy of making a quick guess after eliminating the most obviously discrepant alternatives may be adopted, resulting in shorter response latencies and higher error rates. Both of these strategies can be viewed as variants of a speed-accuracy tradeoff. In the first, speed is scarificed for accuracy, while in the second, the tradeoff occurs in the reverse direction.

One means of assessing the relative role of style versus strategy in the performance of the MFF is to assess the long term stability of performance for individuals. If stability exists, an argument can be made supporting differences in performance as a function of style. Messer (1976) reports that while response latencies on the MFF show moderate stability for school children, errors do not. Kagan (1966) reports a tendency for children to become increasingly reflective with age, a finding which could be interpreted as supporting the notion that as children grow older they are more likely to trade speed for accuracy. If indeed it is the case that MFF performance reflects the adoption of strategies and that becoming "test wise" with increasing exposure to the educational system results in increased emphasis on accuracy, it might be expected that college students would show very little variance in their performance on the adult version of th [illegible] Perhaps it has been the acceptance of this assumption that [illegible] resulted in the apparent lack of interest of the reflective-impulsive dimension in adults. However, increasing concern for individual differences in information processing (cf. Hunt & Lansman, 1975) and the rich, though inconclusive data accumulated on the MFF as a measure of cognitive style in children provide the background for the exploratory studies on the role of strategies and styles reported below.

The following studies were conducted to examine the performance of college students on the adolescent-adult version of the MFF. One purpose was to provide some normative data on the adolescent-adult version of the MFF. In addition, these studies explore the relative contributions of the style or individual difference component and the strategy component of performance of the MFF. It was expected that the strategy component would be affected by instructions that emphasized either speed or accuracy. It was further expected that an instructional set favoring accuracy would result in a reduction in the variance in the performance of the sample by increasing the amount of time to approach as a limit that required for near error free performance. To the extent that the MFF is a valid means of assessing individual differences in cognitive styles in adults, characteristic patterns of speed-accuracy tradeoffs should emerge for individuals classified as having different styles. Such differences to be classified as stylistic should occur regardless of the strategy implied in the instructions and should result in recognizable patterns of speed-accuracy tradeoffs for individuals having different styles.

Experiment I examined the range of performance on the adult version of the MFF by college students and provided some normative data for comparison with the subsequent experiments. In addition, performance on the MFF was examined for possible sex differences, its relationship to extraversion, and the possible role of test anxiety. Obviously, a problem arises in the use of the continuous variables of latency and errors to classify subjects into discrete categories such as impulsive and reflective. However, to make the results more readily comparable to those reported for children, the traditional classifications of reflective, impulsive, fast-accurate, and slow-inaccurate are reported. Experiment II was devised to explore the role of instructions emphasizing accuracy on the performance of the MFF. Experiment III was directed at ascertaining the impact of overt timing on error rates and response latencies. Each of these studies was exploratory in nature and each was concerned with the nature of performance on the MFF per se rather than the behavioral correlates of that performance. A comparison of the results of the experiments will be withheld for the general discussion.

Experiment I

Method

Subjects. Subjects were 24 male and 22 female undergraduate volunteers from introductory level psychology classes at a medium sized midwestern university. All subjects had been previously tested on a battery of personality tests, including the Text Anxiety

Scale (Sarason, 1972) and the Eysenck Personality Inventory (Eysenck & Eysenck, 1964), which were administered in a large group setting.

Materials. The adolescent-adult version of the Matching Familiar Figures test consists of two practice trials and 12 test trials. Each test trial consists of a line drawing of a common object located at the top of the booklet and a series of eight similar line drawings beneath it. The subject's task is to select from the array of eight alternatives the single alternative that exactly matches the standard in every detail. The latency to the initial selection and the errors on each trial are recorded.

Procedure. The MFF was administered to subjects individually in an experimental room in which the subject sat across a table from the experimenter. The subjects were given the following instructions:

> The task you will be doing is the Matching Familiar Figures test (the subject was shown the first practice trial). On the top page there is a standard figure and beneath it there are several alternatives. On each trial there will be one alternative that exactly matches the standard in every detail. Your job will be to select the correct matching alternative. I will be timing your responses, but you have as much time as you need. If you select the correct alternative, I'll tell you and we'll go on to the next trial. If you are incorrect in your selection, I'll tell you and ask you to make another selection.

The experimenter held a stop watch such that the watch, but not the elapsed time, was visible. After a correct response, the experimenter recorded the time, said "That's correct," reset the watch, and turned the page to the next trial. After an incorrect response, the experimenter recorded the time, said "That's incorrect, please select another alternative."

Results and discussion. The mean error rate for the 12 test trials for the group was 11.08 ($SD = 6.85$), with a range from zero to .33. The average sum of latencies to initial responses was 552.7 seconds ($SD = 241.6$), with a range of 147 seconds to 1012 seconds. Split-half reliabilities for errors ($r = .401$, $p < .001$) and latencies ($r = .761$, $p < .001$) indicate a stability on these dimensions that is equivalent to that found in the literature on children's performance on the equivalent form of the MFF (Messer, 1976). The correlation between errors and latencies was $-.433$, $p < .001$, again a relationship similar to those reported by Messer.

The mean extraversion score from the EPI was 11.42 ($SD = 3.44$). Extraversion scores were uncorrelated with either latency ($r = .10$) or errors ($r = .18$). The mean score on the Text Anxiety Scale was 13.8 ($SD = 6.8$). Test anxiety scores were also uncorrelated with either summed latencies to initial responses ($r = .08$) or total errors ($r = -.13$). No significant sex differences were obtained for either latencies or errors.

The latency to initial response and the number oferrors for each trial were computed for each subject. A median split on the summed latencies to initial responses (Md = 531 seconds) divided the subjects into fast and slow groups. A second median split on errors (Md = 9.1) divided the group into accurate and inaccurate responders. These divisions resulted in 18 individuals being classified as slow and accurate (reflective); 14 who were classified as fast and inaccurate (impulsive); six who where slow-inaccurate, and eight who were fast-accurate. The proportion of impulsive and reflective classifications is quite close to the two thirds found in most investigations with children (Messer, 1976).

The data from the first experiment, in addition to providing some normative basis for comparison with the data to be discussed in the subsequent studies, indicate that adult performance is parallel to the performance of children on the equivalent forms of the MFF. The data indicate no relationship between MFF performance and extraversion, test anxiety, or subject's sex. The classification of adult subjects into the dimensions traditionally used with the MFF appears to be at least as legitimate as such classifications in children, in that a sufficient range of performance was obtained to make those classifications. The problems with such classifications will become more evident when the results of the subsequent experiments are presented.

If one accepts the rationale that differences in performance on the MFF are the result of the adoption of different strategies by subjects, the split-half reliability data indicate that such strategies are fairly consistent for individuals across trials.

The second experiment was aimed at exploring the performance of a similar sample when a mild manipulation of the value of accuracy was included. The intended effect was to provide all subjects with a rationale for increasing accuracy at the expense of speed. The MFF is a task which requires only visual acuity and some minimal capacity for visual information processing to achieve perfect accuracy--given sufficient time. For this reason, it seemed inappropriate to use a manipulation that would increase accuracy to the asymptotic limit as a means of assessing the impact of strategies on performance. If providing a rather subtle emphasis on accuracy would be sufficient to alter the pattern of results obtained in Experiment I, then the effects of a strategy could be examined without eliminating errors from the analysis of cognitive style. If the implicit adoption of strategies was the basis for the pattern of data obtained in Experiment I, providing a group of subjects with the same strategy should function to homogenize the data. If, on the other hand, individual differences in information processing (style) is responsible for the pattern of data obtained in Experiment I, then the emphasis of a strategy should function to shift the speed-accuracy tradeoff for all subjects, and the basic pattern of data would remain unchanged. The second experiment followed the same procedure as the first, with the exception that subjects rated their confidence in their initial selection immediately after making a selection on each trial. This procedure provided the subjects with a rationale for concentrating on accuracy throughout the performance of the MFF.

Experiment II

Method

Subjects. Fifty volunteers, drawn from the same subject pool as in Experiment I participated in Experiment II.

Procedure. Participants in the expeirment completed the MFF under the same instructions as in Experiment I, with the exception that the subjects rated their confidence in their selection of an alternative after the initial selection on each trial. A seven point scale, anchored at one extreme with "not at all confident" and at the other with "very confident" was checked by the subject immediately after the initial selection of an alternative on each trial and prior to the subject receiving feedback about the accuracy of the selection.

Results and discussion. Compared to Experiment I, the use of confidence ratings was effective in reducing the overall error rate for the group (M = 7.48, SD = 4.87) and increasing latencies (M = 788.8 seconds, SD = 363.6). The range for errors was from zero to 19 and the range for latencies was from 272 to 1913 seconds. The median splits on errors (Md = 7.3) and latencies (Md = 803 seconds) resulted in 17 subjects being classified as reflective, 15 as impulsive, 10 as fast-accurate, and eight as slow-inaccurate. The mean error rate for the reflective classification was 3.29, while the average error rate for the impulsive classification was 12.2. Corresponding summed latencies for the classifications of reflective and impulsive were 1087 seconds and 459 seconds. The correlation between latencies and errors was $-.45$, $p < .001$.

Surprisingly, there was no pattern of differences in confidence ratings for accurate, inaccurate, fast or slow classifications, nor were there differences for the interactions of these classifications. The confidence rating for each trial was apparently made independently of the errors made on previous trials.

Experiment II demonstrated that altering the administration of the MFF to enhance the importance of accuracy was effective in reducing the group error rate and increasing the mean latencies to initial responses. This manipulation, however, had little effect on the proportion of individuals classified as reflective or impulsive, and appeared to simply have shifted the speed-accuracy tradeoff for all subjects in a relatively consistent manner. Although the manipulation restricted the range of errors and expanded the range of latencies for the group, the effect appeared to be uniform. It is obvious that establishing norms in the traditional sense would not be entirely appropriate for the MFF if the classifications are to be retained. A classification based on latencies and error rates for one experiment would not necessarily be comparable to a classification obtained in a separate experiment.

Providing subjects with a rationale for emphasizing accuracy resulted in increased accuracy and longer latencies in Experiment II, however, some subjects may have been responding to the presence of the stopwatch, the frustration of incorrect responses, or some combination of both. Experiment III was devised to eliminate these two possible sources of implicit strategies for the first six trials of the MFF, then institute them on the last six trials. If response strategies relevant to the speed-accuracy tradeoff are adopted as a function of an attempt to respond quickly rather than accurately, such strategies should be eliminated if no clock is present. The elimination of overt timing thus eliminates a cue for trying to "beat the clock" with the fast but poorly considered selections. In addition, strategies related to quickly eliminating alternatives were rendered useless by allowing the subjects only a single selection of an alternative on each trial. It was assumed that eliminating these sources of implicit strategies would reduce the role of strategies in performance.

Experiment III

Method

Subjects. Thirty-eight students from the same population as the previous experiments participated in the experiment.

Procedure. The MFF was administered individually by an experimenter who preceded the task with a practice trial, then instructed the subject to select the alternative on each trial that exactly matched the standard. The experimenter emphasized that only one alternative exactly matched the standard on each trial. At the beginning of each trial the experimenter activated a stop clock by means of a hidden foot pedal. The clock was located in an adjoining room and latencies were recorded by a second experimenter. At the end of each trial the experimenter recorded the alternative selected by the subject and asked the subject to continue with the next trial. For the first six trials the subject was unaware that the latencies were being recorded and was given no feedback regarding the accuracy of the selected alternative. At the end of the sixth trial, the experimenter took out a stop watch and gave the standard instructions for the MFF as reported in Experiment I.

Results and discussion. Because of the number of possible errors on trials one through six was restricted by the procedure, the classification of accuracy using error rate is not completely comparable with the first two experiments. However, the mean number of error free trials on the first half of experiment III was 3.2 (SD = 1.53), compared to 4.0 (SD = 1.72) for the last six trials. The number of error free trials from the first to the second half correlate .64, $p < .001$, indicating a somewhat higher correspondence of accuracy than found in the first two experiments. The average summed latencies for the first six trials was 337.4 seconds versus 364.8 seconds for the last six trials. The correlation between latencies on the first half and the second half was .79, $p < .001$.

In general, it appears that the overt timing of response latencies had little effect on subjects' performance. In addition, the feedback about errors provides relatively little information for changing strategies as can be seen by the high correlation between error rates for the first and second halves. These results tend to argue against an interpretation of performance on the MFF by college students as being the result of implicit strategies.

General discussion

Tasks such as the MFF involve selecting a single correct response from a finite number of alternatives and require no unique abilities to perform. Such tasks allow that, given sufficient time, any individual capable of making the necessary visual discriminations could perform with 100% accuracy. It is assumed that for any such task, we can predict for a given population the effects of time limitations on errors--at some restricted viewing time errors will approach some maximum limit. Conversely, if unlimited time were available and efficiently used by the subjects in scanning the alternatives, perfect performance with respect to accuracy could be achieved. However, some individuals will require much less time than others to achieve errorless performance. This difference can be conceptualized as a measure of visual information processing efficiency. Individuals who can achieve errorless performance in relatively less time than the average required for a population are relatively more efficient in their information processing. Efficiency in this context is equivalent to the cognitive style dimension discussed earlier. When viewed from this perspective, visual information processing efficiency is a relatively stable individual difference which can be taken as a limit on the speed-accuracy tradeoff. Any attempt to increase accuracy beyond the limit imposed by the individual's efficiency index will cost time. Situational factors can function to cause apparent fluctuations in the tradeoff point, but such factors (e.g., anxiety, fatigue, instructional set, etc.) will not improve on the limit.

For the MFF, the range of performance with respect to accuracy is relatively small. Errors can range from a minimum of zero to a maximum of fewer than 84 (when the probability of random correct selections is considered). However, even with this limitation, a relatively small sample can provide us with an approximation of the task requirements for the MFF. The number of seconds necessary for the average individual to produce a given number of correct responses can be calculated. Unfortunately, the standard manner of using the MFF to compare time and errors does not lend itself to this computation. The number of errors is computed for the entire trial, but the latency is computed only for the initial response. An approximation of the speed-accuracy tradeoff for the MFF can, however, be arrived at by using the number of error [illegible] trials in the computation, rather than the [illegible] of errors. This estimate of accuracy places rather severe restrictions on the range, because it can now vary only from zero to less than 12. Because of the small number of trials, we can at best offer only a rough approximation of the limits on performance of the MFF for a population.

To the extent that the speed-accuracy tradeoff for a population performing the MFF can be estimated from a sample and considered to be an average of that sample's performance, an approximation of the speed-accuracy requirement for the MFF can be obtained from the formula:

$$L \times \%E = K$$

where L is the sum of latencies to initial responses, % E is the percent of trials on which an error occurred and K is a constant representing the speed-accuracy requirement for the MFF.

Consider the average latencies for the three experiments discussed above: 552 seconds, 788 seconds, and 702 seconds. Consider in addition a fourth experiment not discussed in detail, but using 20 subjects from the same population who yielded a mean sum of latencies of 520 seconds. The percent of trials on which an error occurred on these four experiments was 41.9, 36.8, 39.3 and 48.8, respectively. Using the time and error data from the first experiment as a comparison point and the formula:

$$\frac{L_1}{L_2} = \frac{1/\%E_1}{1/\%E_2}$$

the expected error rate for the remaining three experiments can be calculated by knowing the summed latencies. From the first experiment, and given the summed latencies for the second experiment, an error rate of 34.5% would be predicted. The actual error rate of 36.8% is quite close to that predicted. For Experiment III, the predicted and actual error rates are 38.6% and 39.3%, respectively. For the final experiment, which was not reported in detail, the values are 51.2% and 48.8% for the predicted and actual error rates, respectively.

Although only a relatively small part of the suggested curve for the speed-accuracy tradeoff of the MFF is represented in these data, the close correspondence between the predictions and the outcomes suggest an alternative way of using the MFF. Examination of the speed-accuracy points at very short latencies would certainly yield accuracy at only chance levels. However, examination at very long latencies, where subjects are required to delay responses for long periods of time, boredom or fatigue may preclude ongoing information processing for the total duration.

The research presented here has rather broad implications for interpreting the previous research on children. While the MFF does appear to have considerable utility in deter[illegible] indivi[illegible] differ[illegible] the nature of these individual diff[illegible]ces (in adults) appears to be more related to information processing efficiency rather than inability to delay responses, anxiety over errors, or ideosyncratic implicit strategies. These data further point out the problems of classification as a function of performance on the MFF. The speed-accuracy tradeoffs for impulsive and reflective classifications are actually the ones with the greatest overlap. The two groups which have been traditionally excluded from analyses of MFF data--the fast-accurate and the slow-inaccurate--represent the extremes of performance when efficiency indices are used. An analysis of performance of the MFF which uses the speed-accuracy tradeoff outlined above should eliminate some of the problems of comparisons of performances in studies where different median latency and error rates make the impulsive-reflective classification system inappropriate.

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