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Recognition memory for pictures: Evidence for a feature-analytic basis of cognitive style

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Twenty-two reflective and 22 impulsive college subjects were tested in a forced-choice visual recognition memory task. Half of the reflective and half of the impulsive subjects were shown the presentation stimuli for 4 sec each; half were shown the stimuli for 8 sec each. In three of the experimental conditions (1FD, 2FD, 4FD), the number of visual feature differences between the correct and incorrect test stimuli was 1, 2, or 4, and correct response could not be based on the name of the stimulus. In the fourth condition (DO), the correct and incorrect test stimuli had different names. As predicted, performance on DO and 4FD was equivalent and was superior to that on 1FD and 2FD. Mean correct response latencies mirrored the correct response data. Although reflective subjects made more correct responses than did impulsive subjects in all four conditions, only the performance differences in Conditions 1FD and 2FD were significant. Neither the main effect of initial exposure time nor the R-I by Exposure Time interaction was significant. These results were discussed within the framework of the Selfridge-Neisser feature-testing model of recognition memory, and the data support the contention that the primary underlying basis for the dimension of reflection-impulsivity is that of detailed visual feature analysis of stimulus arrays.

The dimension of reflection-impulsivity (R-I) is claimed to be a reliable and useful dimension along which to conceptualize individual differences in cognitive style. An individual's relative position on this dimension is typically determined by his or her performance on the Matching Familiar Figures test (MFF) (Kagan & Kogan, 1970; Kagan, Rosman, Day, Albert, & Phillips, 1964). In the MFF, the subject is shown a standard stimulus and is then asked to choose the one of several strikingly similar variants that exactly matches the standard. Subjects who respond slowly and make relatively few errors are classified as "reflective," while subjects who respond quickly and make many errors are classified as "impulsive."

Performance differences between reflective and impulsive subjects are assumed to reflect a broad and pervasive dimension of individual differences in approach to problems involving high response uncertainty (Kagan et al., 1964). On the basis of this assumption, much research has been devoted to demonstrating that the performance of reflective children is higher or better on such diverse tasks as reading (Kagan, 1965), inductive reasoning (Kagan, Pearson, & Welch, 1966), and hypothesis-testing (Nuessle, 1972). Little or no research of this kind has been carried out with adults.

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Zelniker, Jeffrey, Ault, and Parsons (1972) recorded eye fixations on the MFF and proposed that impulsive children have less adequate strategies for searching the stimulus complex. Odom, McIntyre, and Neale (1971) found that on a task of perceptual learning, reflective children perceived and evaluated information based on the feature differences of stimulus arrays; the information processed by the impulsive children could not be identified. Thus, it is possible that the R-I performance differences reflect differences in a specific visual process rather than in broad "cognitive predispositions." Zelniker et al. (1972) and Siegelman (1969) suggest that reflective and impulsive children differ in their perceptual approach to the MFF, and Drake (1970) and Odom et al. (1971) suggest that reflective children perform differential feature analyses of stimulus arrays.

Kilburg and Siegel (1973) and Siegel, Babich, and Kirasix (1974) have argued that the underlying basis for R-I differences is the process of visual feature analysis, and that the Selfridge-Neisser model of pattern recognition (Neisser, 1966; Selfridge, 1959, "Pandemonium") is theoretically useful in accounting for (and predicting) many of the performance differences between reflective and impulsive subjects. This model is hierarchical and is based on a program for letter recognition which emphasizes feature testing.

The present study represents an attempt to investigate the effect of exposure time on the recognition memory performance of adults who have been identified as reflective and impulsive. Rather than selecting two arbitrary exposure times, separate groups of reflective and impulsive subjects were tested first. The average time taken to go through the presentation stimuli was divided by the number of items for the reflective and impulsive subjects, respectively, and this determined the exposure time for a second group of reflectives and impulsives. The second group of reflectives were then shown the presentation stimuli for the same amount of time as the first group of impulsives; similarly, the second group of impulsives were shown the presentation stimuli for the same amount of time as the first group of reflectives. If performance in the various conditions is not markedly affected by a large difference in initial exposure time, this will provide additional evidence that R-I differences occur at Level 2 of the feature testing model rather than at Level 1 (gross stimulus sampling).

As had been found previously with children (Kilburg & Siegel, 1973; Siegel et al., 1974), the overall performance of reflective subjects was predicted to be superior to that of impulsives. More importantly, an interaction was predicted between R-I and the particular conditions under which recognition memory was tested. In this study, recognition memory was tested under four different experimental conditions for each subject. In Conditions 1FD, 2FD, and 4FD, the correct and incorrect test stimuli differed in one, two, or four visual features (but had the same name); in Condition DO, the incorrect stimulus was a different object or animal. Reflectives and impulsives should differ only in conditions in which *detailed* visual feature analyses are required—Conditions 1FD and 2FD—but not in conditions where a more global feature analysis would suffice to produce a correct response (Conditions 4FD and DO). Generally, the more detailed a feature analysis required (i.e., the fewer features distinguishing the correct and incorrect stimuli), the greater should be the advantage of the reflectives: The difference should be greatest in 1FD, next greatest in 2FD, and least in 4FD and DO.

On the basis of the Neisser-Selfridge feature testing model for recognition, it was generally expected that the greater the number of feature differences between correct and incorrect test stimuli, the better would be the recognition memory performance. On the basis of previous research (Kilburg &Siegel, 1973; Siegel et al., 1974), it was expected that performance in Conditions 4FD and DO would be equivalent and superior to that in 1FD and 2FD. Latency differences were also predicted. Latencies for correct responses should be longest in Condition 1FD, next longest in 2FD, and shorter in both DO and 4FD (the latter two should not differ).

METHOD

Subjects

Sixty-five college students, 36 females and 29 males, participated in the research (mean CA = 20 years) on a volunteer basis.

Procedure

R-I classification. The Matching Familiar Figures test (Kagan et al., 1964) was used to classify subjects in the dimension of reflection-impulsivity (R-I). All 65 subjects were individually administered the MFF during a first session. The essential instructions to the subject were that he or she was to point to the one of eight variants (on the lower page) that was exactly like the standard (on the upper page). The other seven variants differ from the standard in one small visual detail. For each of the 10 test items, the experimenter recorded the number of errors made and the response latency for each item (time from presentation to first response, whether correct or not). Subjects whose mean response latency was above the median (51.2 sec) and whose total number of errors was below the median (8) were classified as reflective; subjects whose mean latency was below the median and whose total errors were above the median were classified as impulsive. Of the 65 subjects tested, 22 were classified as reflective and 22 as impulsive. Subjects whose scores fell at either median were excluded.

Stimulus presentation. In a second session held approximately 1 week later, 11 reflective and 11 impulsive subjects were randomly selected (approximately equal numbers of males and females in each group) and administered the recognition memory task. Stimuli for the presentation task was a deck of 96 3 x 5 in. laminated card, on each of which was a black line drawing of a common animal or object. Each subject was seated, handed the presentation deck of 96 cards, told to look at each of the cards, turn each over when finished, and to go through the entire deck. The subject was allowed to go through the deck at his own pace. The total amount of time the subject took to go through the deck (i.e., look at all 96 stimuli) was recorded.

Recognition test. Following this, subjects were individually given the test for recognition memory. The test deck consisted of 96 5 x 8 in. laminated cards, on each of which were two black line drawings. The apparatus consisted of a test stand on which each of the test cards was placed. At the bottom of the stand was a photocell-controlled microswitch wired to a Hunter timer (facing the experimenter), which started each time a new card was placed on the stand. In front of the stand and below the two stimulus loci were response buttons. Pressing either button automatically stopped the timer. The experimenter manually recorded the response latency. The subject was told that he would be shown some more cards, each with two drawings on it, and that he was to look at both drawings and push the button underneath the one that he had seen before in the first part of the task. The subject was instructed to push the button as quickly as he could. Each subject was then shown all 96 test cards, one at a time. For each test card, the experimenter recorded whether the response was correct or incorrect and the response latency.

The mean time taken to go through the presentation deck was computed separately for the 11 reflective (766 sec) and 11 impulsive (377 sec subjects. Dividing these means by 96 yhielded the average time that each card was looked at: 7.98 sec/card for reflectives; 3.93 sec/card for impulsive subjects. These mean values were then used as the exposure times for the presentation of stimuli to the remaining 22 subjects.

The remaining 11 reflectives and 11 impulsives were then individually administered the recognition memory task. The procedures used were identical to those used above with one important exception: The 11 reflectives were shown the presentation stimuli at a rate of one stimulus/4 sec, and the 11 impulsives were shown the stimuli at a rate of one stimulus/8 sec. A silent Paquet metronome was used to time stimulus presentation.

Experimental Conditions

The recognition test consisted of 96 cards, 24 for each of four experimental conditions. Within each set of 24, the correct figure was on the left for 12 of the cards, and on the right for the other 12. All subjects saw the 96 test stimuli in the same, completely randomized order. Examples of presentation and recognition test items for each of the four experimental conditions are presented in Figure 1.

Condition DO (different object(: 24 stimuli were chosen randomly from the 96 original stimuli and each was paired with a completely different animal or object on the test card.

Condition 1FD (one-feature difference): 24 different stimuli from the original presentation stimuli were each paired with another stimulus having the same name, but differing from the original stimulus in *one* visual detail.

Condition 2FD: 24 different stimuli from the original presentation stimuli were each paired with another stimulus having the same name, but differing from the original stimulus in *two* visual details.

Condition 4FD: The remaining 24 stimuli from the original presentation stimuli were each paired with another stimulus having the same name, but differing from the original stimulus in *four* visual details or features.

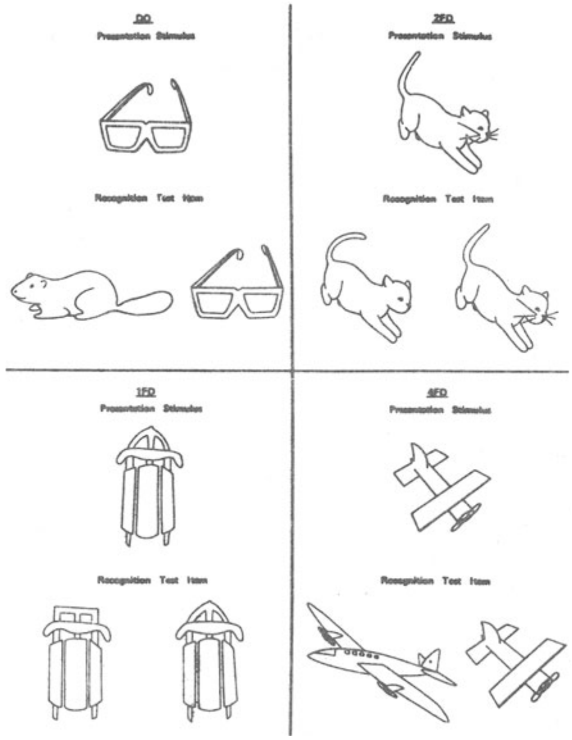

Figure 1

RESULTS

A 2 (R-I) by 2 (exposure time) by 11 (subjects/cell) by 4 (conditions) repeated measures analysis of variance was performed on the number of correct responses in each condition for each subject. As predicted, the main effect of R-I was highly significant, $F(1,40) = 60.88$, $p < .0001$: Reflective subjects made significantly more total correct responses (91.32/96 or 95%) than did impulsive subjects (83.77/96 or 87%). The R-I by Exposure Time interaction was highly significant, $F(1,40) = 16.34$, $p < .0001$. However, since this represents pooled performance over four experimental conditions, and since we were interested in R-I differences in the various conditions, this R-I by Exposure Time interaction is of little interest. The main effect of exposure time was not significant, $F < 1$.

The main effect of condition was, as expected, highly significant, $F(3,120) = 49.16$, $p < .0001$. Scheffé (.01) confidence intervals (MSE = 1.98, CV = 1.03) indicated that, as predicted, performance in Conditions DO and 4FD (96% and 97%, respectively) was equivalent. Performance in both was significantly better than in either Condition 1FD or Condition 2FD (both 86%); performance on 1FD and 2FD did not differ. That performance in DO and 4FD was equivalent and that a correct response in 4FD could not be made on the basis of the name of the stimulus (e.g., both correct and incorrect test stimuli were airplanes) provides strong inferential evidence that visual recognition memory is determined by a process of visual feature analysis, and that verbal labels have little or no direct effect on visual recognition performance.

Finally, as predicted, the R-I by Condition interaction was highly significant, $F(3,120) = 6.09$, $p < .01$. The means and standard deviations of the number of correct responses made in each condition by reflective and impulsive subjects are also presented in Table 1. Scheffé (.01) confidence intervals (MSE = 1.98, CV = 1.44) indicated that the patterns of results were similar for reflective and impulsive subjects. Performance on Condition DO was equivalent to that on 4FD, and performance on both was significantly greater than that on 1FD and 2FD; the latter two conditions did not differ significantly. Comparisons between reflectives and impulsives on the same conditions, however, revealed the source of the interaction. The performance of reflectives was significantly greater than that of impulsives only in Conditions 1FD and 2FD—the conditions requiring the most detailed visual feature analyses in order to make a correct response. As predicted, for conditions in which only visual features (and not the name) differentiated correct and incorrect test stimuli (i.e., 1FD, 2FD, 4FD), the superiority of the reflectives increased as the number of differentiating visual details decreased. Whereas the difference between reflective and impulsive performance was only 0.77 correct responses (a difference of 3%) in Condition 4FD, the advantage increased to 2.45 (10%) in 2FD, and increased even further to 3.04 (13%) in Condition 1FD. The R-I by Exposure Time by Condition interaction was not significant, $F < 1$.

Each subject's mean latency for each of the four experimental conditions was computed on the basis of correct responses only. A 2 (R-I) by 2 (exposure time) by 11 (subjects/cell) by 4 (conditions) repeated measures analysis of variance was performed on the mean correct response latency in each condition for

Table 1
Means and Standard Deviations of the Number of Correct Responses for Reflectives and Impulsives in Each of the Experimental Conditions

	Condition							
	1FD		2FD		4FD		DO	
Group	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Reflectives (N = 22)	22.09	1.45	21.86	1.16	23.68	0.62	23.68	0.54
Impulsives (N = 22)	19.05	1.44	19.41	2.06	22.91	0.82	22.41	1.66
All Subjects (N = 44)	20.57	1.45	20.64	1.67	23.30	0.73	23.05	1.23

each subject. Only the main effect of condition was significant, $F(3,120) = 59.59$, $p < .0001$. Scheffé (.01) confidence intervals (MSE = .200, CV = .32) indicated that the mean latency in Condition 1FD (3.01 sec) was significantly longer than that in 2FD (2.43 sec). Mean latencies in both Conditions 1FD and 2FD were significantly longer than those in 4FD (1.89) and DO (1.94); latencies in 4FD and DO were equivalent. Neither the main effect of R-I, nor exposure time, nor any interactions were significant, all Fs < 1.

DISCUSSION

The results of the present study are congruent with earlier research with children (e.g., Drake, 1970; Kilburg & Siegel, 1973; Odom et al., 1971; Zelniker et al., 1972): Performance differences between reflective and impulsive adults were found on a task requiring visual feature analyses. Although the performance of reflectives was superior to that of impulsives in all conditions, the difference was significant only in Conditions 1FD and 2FD—the conditions requiring the most detailed feature analyses. Since each of the MFF variants differs from the standard in only one visual feature, and this instrument is used to assess reflection-impulsivity, these data imply that the underlying basis for the R-I dimension is a process of visual feature analysis rather than a broad, cognitive disposition. Additionally, the finding of the predicted increase in the advantage of reflectives as the feature analysis required gets more difficult indicates that reflective-impulsive performance differences can be specified by a feature-analytic model of pattern recognition.

The response latency data also provide confirmation of the applicability of the Selfridge-Neisser model to R-I performance differences in recognition memory. Correct response latency was inversely related to the number of feature differences between correct and incorrect test stimuli: The greater the number of feature differences between the correct and incorrect test stimuli (both having the same name), the shorter the response latency. That is, when there was only one feature difference between the correct and incorrect test stimuli, a very detailed feature analysis had to be performed during initial presentation, and a large number of feature tests had to be made during the test itself in order to make a correct response. Our data indicate that the time taken to correctly identify a stimulus asymptotes at about four feature differences, since the latency in DO (correct and incorrect stimuli differed in an infinite number of visual features) and 4FD were equivalent.

That both correct responses and latencies in Conditions 4FD and DO were equivalent confirms previous evidence which indicates that correct recognition in both conditions is primarily dependent on visual processes and is relatively independent of verbal processes. Although a correct recognition response could perhaps be made on the basis of the name of the stimulus in DO, a correct response in 4FD could not (i.e., both correct and incorrect test stimuli had the same name).

In summary, the results from the present experiment indicate that (1) reflective and impulsive adults differ in their propensity to engage in a detailed feature analysis of visual stimuli; (2) visual feature analysis seems to be a most significant component in the underlying basis of the dimension of R-I; and (3) the level of recognition performance is strongly influenced by the nature of visual feature differences between correct and incorrect items.

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