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Visual Recognition Memory: The Effect of Cognitive Style and Exposure Time

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Visual Recognition Memory: The Effect of Cognitive Style and Exposure Time

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Abstract

Twenty-two reflective and 22 impulsive college students were tested in a forced-choice recognition memory task. Half of the reflective subjects were shown the presentation stimuli for eight seconds each and the remaining half were shown the stimuli for two seconds each. Half of the impulsive subjects saw the presentation stimuli for four seconds each, while the remaining half saw the stimuli for ten seconds each. In three of the experimental conditions the number of visual feature differences between the correct and incorrect test stimuli was 1, 2, or 4 (1FD, 2FD, 4FD), 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 responses. 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. Whereas initial exposure time had no effect on the overall recognition performance of the reflective subjects, impulsive subjects performed significantly better when given an additional six seconds of stimulus exposure. These results were generally consistent with the Selfridge-Neisser feature-testing model of recognition memory. The data support the contention that the primary underlying basis for the dimension of reflection-impulsivity was that reflective subjects tend to engage in a more detailed visual feature analysis of stimulus arrays, Level 2 in the Selfridge-Neisser model. As in the previous experiments, strong inferential evidence was provided that visual feature analysis, independent of verbal labeling, was responsible for successful recognition performance in these subjects.

VISUAL RECOGNITION MEMORY: THE EFFECT OF COGNITIVE STYLE AND EXPOSURE TIME

Introduction

The problem of pattern recognition is ubiquitous in psychology. Research dealing with pattern recognition has concerned itself with dispalced, rotated, or ill-defined figures, studies of decision time and visual search, stopped-image experiments, single-cell physiological recordings, and developmental studies of visual discrimination (Neisser, 1967). A major concern within this body of research centers on the problem of stable individual differences in cognitive processes. The dimension of cognitive style specifically under consideration in the present study is that of reflection-impulsivity.

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 in this dimension is typically determined by his or her performance on the Matching Familiar Figures test (MFF) (Kagan & Kogan, 1970; Kagan, Rossman, Day, Albert, & Phillips, 1964). In the MFF, a subject is shown a standard stimulus and is then asked to choose one of the 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 makes 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.

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 the stimulus arrays; the information processed by the impulsive children could not be identified. Thus, it is possible that R-I performance differences reflect differences in a specfic 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 Kirasic (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, "Pandemonium", (Neisser, 1966; Selfridge, 1959) 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 model assumes that several levels of mechanisms operate on incoming information: Level 1 mechanisms are stimulus samplers that get basic information into the system; Level 2 mechanisms are stimulus analyzers, each of which determines whether or not the stimulus has certain features. Results of these feature tests are conveyed to the next level where a set of "subroutines" perform operations on the results of the feature tests. At the highest level, the probability values from these subroutines are compared and the item associated with the largest value is selected as the best "guess" as to the identity of the stimulus.

In an initial attempt to determine the applicability of the Selfridge-Neisser model to R-I performance differences, Kilburg and Siegel (1973) tested reflective and impulsive first and fifth-graders in a forced-choice recognition memory task. The possibility that correct recognition responses could be made on the basis of verbal labels, visual features, or both, was systematically varied in the experimental conditions. Reflective children made more correct recognition responses than did impulsive children under all conditions, but this difference was significant only in a condition in which the sole basis for a correct response was a visual feature analysis. On the basis of the patterns of differences between conditions, it was concluded that visual feature analysis independent of verbal processes was responsible for visual recognition memory in these subjects. Using the same task, Siegel et al. (1974) systematically manipulated the number of feature differences between correct and incorrect test stimuli. The hypothesis that reflective children (fifth-graders) engage in a more detailed visual feature analysis of stimulus (Level 2 of the Selfridge-Neisser model) was supported. Reflective children did better than impulsive children under all conditions, but this difference was significant only when there was one feature difference between correct and incorrect test stimuli.

In both studies, subjects were allowed to go through the presentation deck at their own pace. Reflective subjects took longer to do this than did impulsive subjects. Although this difference was minimal (a mean difference of about .25 sec./card), the possibility remains that reflectives did better than impulsives because they were exposed to each stimulus for a longer period of time. A test of this hypothesis requires a systematic manipulation of exposure time.

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. The exposure times selected were obtained by first testing separate groups of reflective and impulsive subjects. The average time taken to go through the presentation stimuli was divided by the number of items for the reflective and impulsive subjects, respectively. After obtaining the average time to go through the presentation stimuli two additional seconds were added to the reflective mean sorting time and two seconds were subtracted from the impulsive mean sorting time. These additions and subtractions on the mean sorting time were done to test the possible limits of exposure time on recognition memory performance. The second group of reflective subjects were then shown the presentation stimuli for the same amount of time, minus two seconds, as the first group of impulsive subjects; similarly, the second group of impulsive subjects were shown the presentation stimuli for the same amount of time, plus two seconds, as the first group of reflective subjects. If reflective subjects have a greater tendency to engage in a detailed feature analysis, then exposure time should have little effect on their performance. However, the additional time given to the impulsive subjects, since they have little else to do but to look at the stimuli, might provide an extra opportunity for them to perform feature analyses of these stimuli. If performance 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 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 feature conditions under which recognition memory was tested. In this study, recognition memory was tested under four different experimental conditions for each subject. In Condition 1FD the correct and incorrect test stimuli differed in one small visual feature (but had the same name), in Condition 2FD they differed in only two visual features (but had the same name), in Condition 4FD they differed in four visual features, and in Condition DO the incorrect stimulus had a different name. Reflective and impulsive subjects should differ only in conditions in which detailed 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 feature analysis required (i.e., the fewer features distinguishing the correct and incorrect stimuli), the greater should be the advantage of the reflective subjects: The difference should be greatest in 1FD, next greatest in 2FD, and least in 4FD and DO.

On the basis of the Selfridge-Neisser 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).

The main effect of exposure time should not be significant, however an R-I x exposure time interaction might be expected on overall performance. Specifically, the performance of the reflective subjects should not be affected significantly by whether the stimuli are presented for two or eight seconds. However, the additional six seconds of exposure time for impulsive subjects might be expected to increase their performance somewhat.

Method

Subjects

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

Stimulus materials

The recognition test consisted of 96 cards, 24 for each 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 randomly chosen from the 96 original stimuli and each was paired with a completely different object or animal 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 (Two 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 <u>two</u> visual details.

Condition <u>4FD</u> (Four Feature Difference): 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 <u>four</u> visual details or features.

<u>Procedure</u>

<u>R-I classification</u>. The Matching Familiar Figures test (Kagan et al., 1964) was used to classify subjects on 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 ten test items, the experimenter recorded the number of errors that the subject 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 seconds) 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 was 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 one 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. The subjects were informed prior to the session that they would be returning for a recognition and recall task. Stimuli for the presentation task was a deck of 96 3x5 inch laminated cards 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.

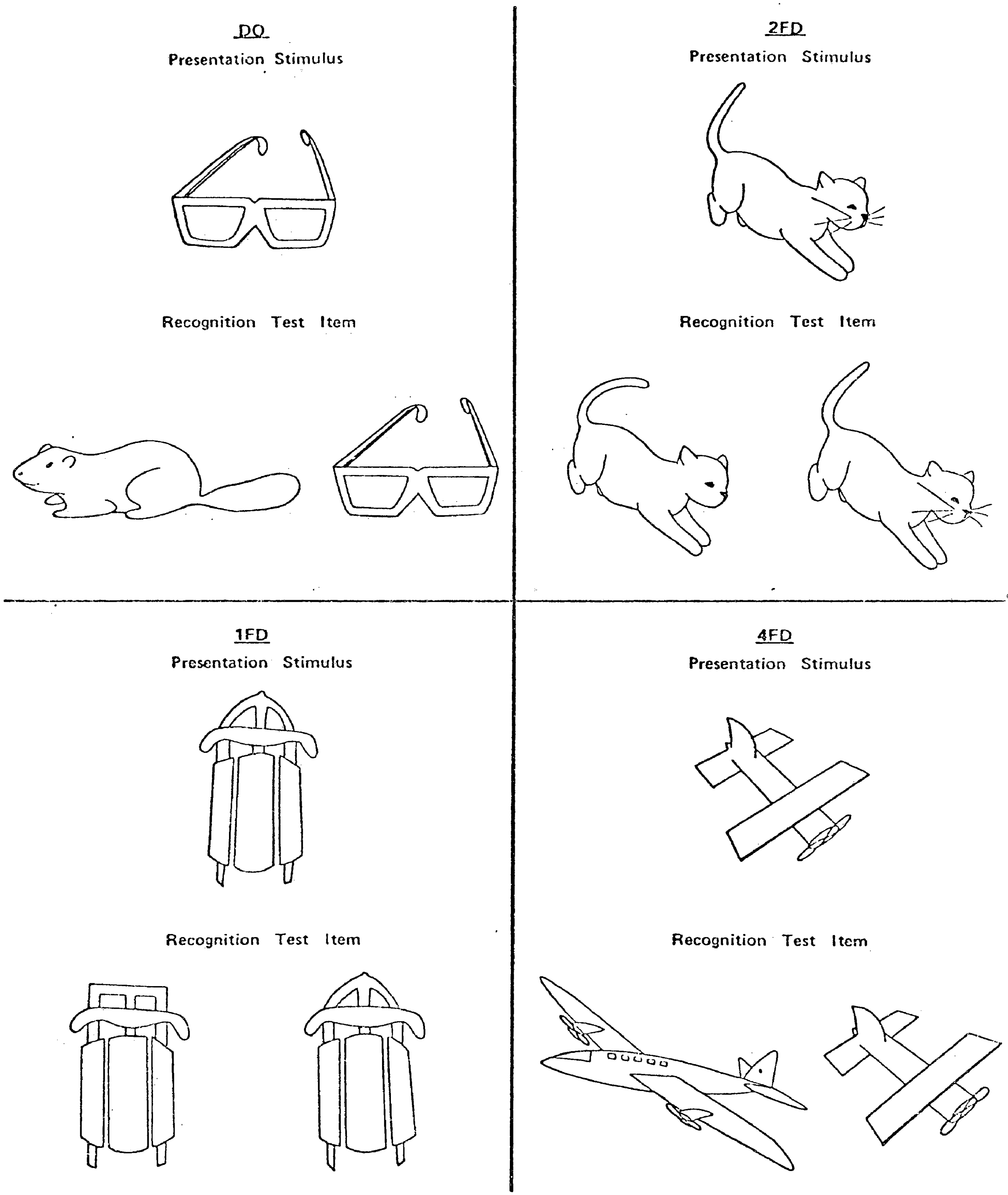
Recognition test. Following this, the subject was given the test for recognition memory. The test deck consisted of 96 5x8 inch laminated cards on each of which were two black line drawings. The apparatus consisted of a test stand on which each of the test cards was placed. At the bottom of the stand 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 seperately for the 11 reflective (766 seconds) and 11 impulsive (377 seconds) subjects. Dividing these means by 96 yielded the average time that each card was looked at: 7.98 seconds/card for reflective subjects; 3.93 seconds/card for impulsive subjects. Two seconds were then added to the reflective mean time and two seconds were subtracted from the impulsive mean time. These new values were then used as the exposure times for the presentation of stimuli to the remaining 22 subjects.

The 11 remaining reflective and 11 impulsive subjects were then individually administered the recognition memory task. The procedures used were identical to those used above with one important exception: The 11 reflective subjects were shown the presentation stimuli by the experimenter at the rate of one stimulus per two seconds, and the 11 impulsive subjects were shown the stimuli at the rate of one stimulus per ten seconds. A silent Piaget metronome was used to time the stimulus presentation.

FIGURE 1

EXAMPLES OF PRESENTATION AND RECOGNITION TEST ITEMS FOR EACH OF THE FOUR EXPERIMENTAL CONDITIONS


DO
Presentation Stimulus
Recognition Test Item
2FD
Presentation Stimulus
Recognition Test Item
1FD
Presentation Stimulus
Recognition Test Item
4FD
Presentation Stimulus
Recognition Test Item

Results

A repeated measures Analysis of Variance, 2 (R-I) x 2 (Exposure time) x 11 (Subjects/cell) x 4 (Conditions), was performed on the number of correct responses in each condition for each subject. A summary of this analysis is shown in Table 1. 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%). Although the main effect of exposure time was not significant, $F < 1$, the R-I x Exposure time interaction was highly significant, $F(1,40) = 16.34$, $p < .0001$. Scheffé (.01) confidence intervals (MSE = 10.28, CV = 4.92) indicated that performance of impulsive subjects who had seen each card for four seconds (their own pace) was significantly poorer than that of any other group (81.36/96 or 85%). Although performance of reflective subjects who had seen the stimuli for eight seconds (89.82/96 or 94%) was not significantly different from that of impulsive subjects who had seen the stimuli for ten seconds (86.18/96 or 90%), when the stimuli were only shown for two seconds, the performance of reflective subjects (93.82/96 or 98%) was significantly greater than that of impulsive subjects (81.36/96 or 85%) who had seen the

Table 1

Analysis of Variance Table for Correct Responses

Source	df	MS	F
Between Subjects	43		
R-I	1	156.57	60.88
Exposure	1	2.27	
R-I x Exposure	1	42.02	16.34
Error between	40	2.57	
Within Subjects	132		
Condition	3	97.23	49.16
R-I x Condition	3	12.04	6.09
Exposure x Condition	3	3.23	
R-I x Exposure x Condition	3	.40	
Error Within	120	1.98	

stimuli for four seconds.

The main effect of condition was, as expected, highly significant, $\underline{F}(3,120) = 49.16$, $\underline{p} < .0001$. 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 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 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 x Condition interaction was highly significant, $\underline{F}(3,120) = 6.09$, $\underline{p} < .01$. The means and standard deviations of the number of correct responses made in each condition by reflective and impulsive subjects are presented in Table 2. Scheffé (.01) confidence intervals (MSE = 1.98, CV = 1.44) indicated that the pattern 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, however, did not differ signifi-

Table 2

Means and Standard Deviations of the Number of Correct Responses for Reflective and Impulsive Subjects in Each of the Experimental Conditions

	Condition							
	1FD		2FD		4FD		DO	
Group	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
Reflective Subjects (N = 22)	22.09	1.45	21.86	1.16	23.68	0.62	23.68	0.54
Impulsive Subjects (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

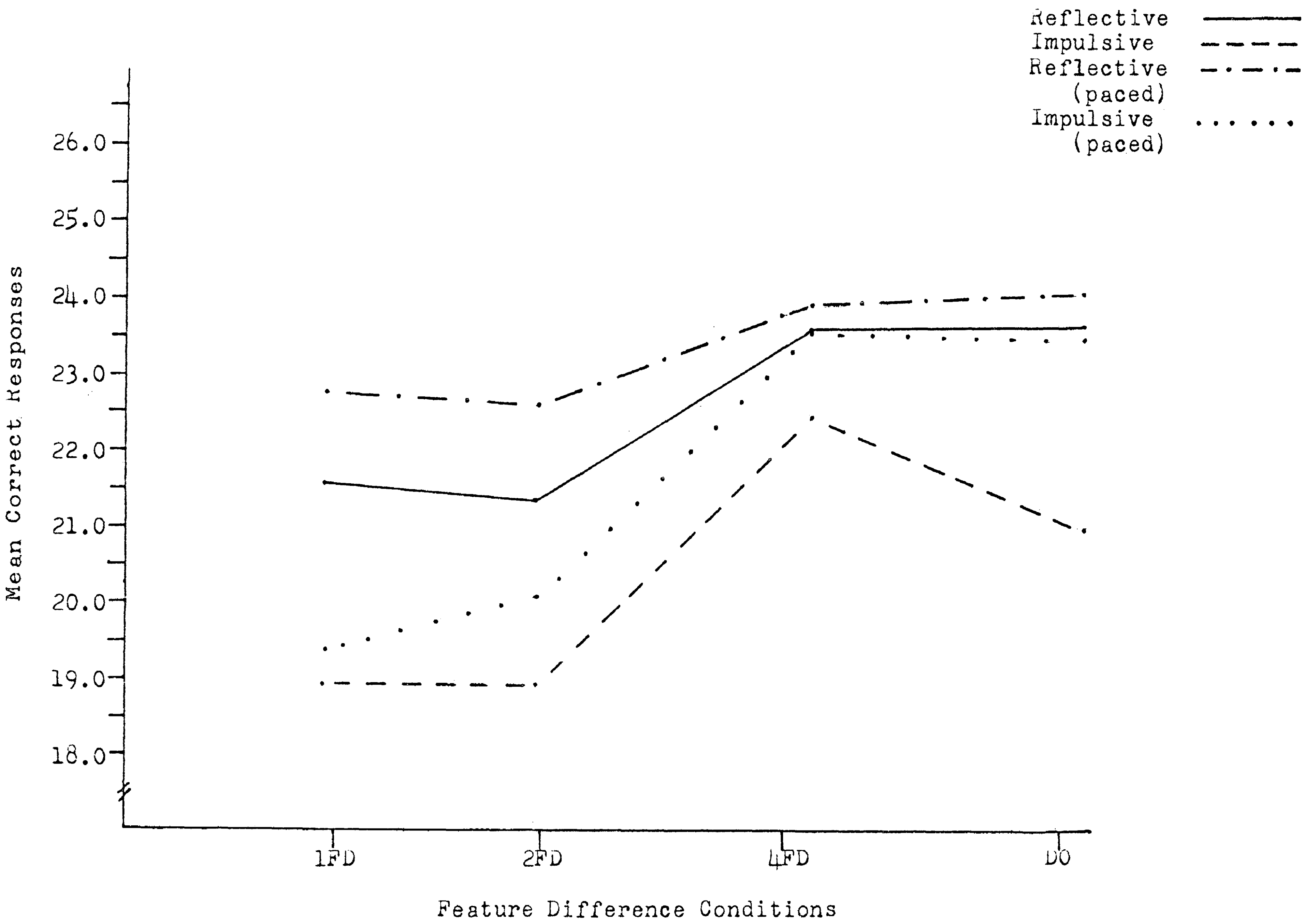
cantly. Comparisons between reflective and impulsive subjects on the same conditions, however, revealed the source of the interaction. The performance of reflective subjects was significantly greater than that of impulsive subjects only in Conditions 1FD and 2FD--the conditions requiring the most detailed 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 reflective subjects 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. Graphic representation for the mean correct responses in all experimental conditions can be seen in Figure 2.

Each subject's mean latency for each of the four experimental conditions was computed on the basis of correct response only. A 2 (R-I) x 2 (Exposure time) x 11 (Subjects/cell) x 4 (Conditions) repeated measures ANOVA was performed on the mean correct response latency in each condition for each subject. A summary of this analysis is shown in Table 3. Only the main effect of Condition was significant, $\underline{F}(3,120) = 59.59$, $\underline{p} < .0001$. Scheffé (.01) confidence intervals (MSE = .200, CV = .32)

FIGURE 2

GRAPHIC REPRESENTATION FOR MEAN

CORRECT RESPONSES IN ALL EXPERIMENTAL CONDITIONS



Reflective
Impulsive
Reflective (paced)
Impulsive (paced)
26.0
25.0
24.0
23.0
22.0
21.0
20.0
19.0
18.0
Mean Correct Responses
1FD
2FD
4FD
DO
Feature Difference Conditions

Table 3

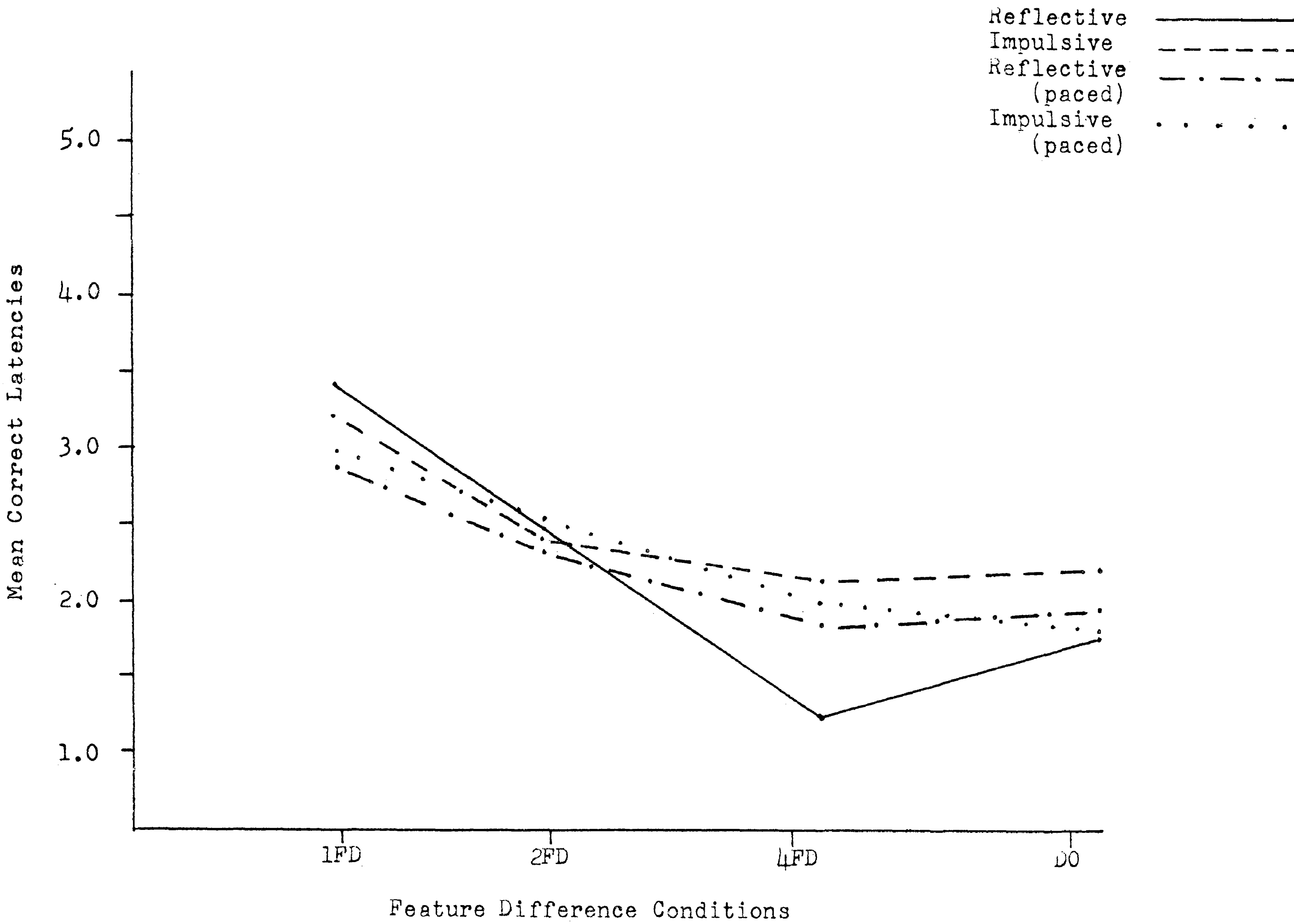
Analysis of Variance Table for Mean Latencies

Source	df	MS	F
Between Subjects	43		
R-I	1	.31	
Exposure	1	.01	
R-I x Exposure	1	.18	
Error Between	40	1.92	
Within Subjects	132		
Condition	3	11.99	59.59
R-I x Condition	3	.17	
Exposure x Condition	3	.12	
R-I x Exposure x Condition	3	.20	
Error Within	120	.20	

indicated that the mean latency in Condition 1FD (3.01 seconds) was significantly longer than that in 2FD (2.43 seconds). Mean response latencies in both conditions 1FD and 2FD were significantly longer than those in 4FD (1.89 seconds) and DO (1.94 seconds); latencies in 4FD and DO were equivalent. Mean response latencies for all experimental conditions are graphically represented in Figure 3. Neither the main effect of R-I, nor Exposure time, nor any interaction were significant, all *F*'s < 1.

FIGURE 3

GRAPHIC REPRESENTATION FOR MEAN RESPONSES LATENCIES FOR ALL EXPERIMENTAL CONDITIONS


Reflective
Impulsive
Reflective (paced)
Impulsive (paced)
Mean Correct Latencies
5.0
4.0
3.0
2.0
1.0
1FD
2FD
4FD
DO
Feature Difference Conditions

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 adult subjects were found on a task requiring visual feature analyses. Although the performance of reflective subjects was superior to that of impulsive subjects in all conditions, the difference was significant only in Condition 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 significant interaction of R-I and Exposure time was primarily due to the increase in overall performance of impulsive subjects when given six additional seconds of stimulus exposure. There was no difference in the performance of reflective subjects when given two seconds of exposure rather than eight (in fact, they made more correct responses when given only two seconds exposure to each stimulus). One possible explanation for this pattern of results is that impulsive subjects, captive in the task as they were (they had no choice but to look at the stimuli more), when given an additional six seconds, perform a more detailed analysis of the stimuli than they do when they look at the stimuli at their own rapid pace. Another possible explanation, which seems unlikely, is that both reflective and impulsive subjects perform better when looking at the stimuli at an externally imposed pace of presentation. It could be argued that this "structures" the task for the subject. The data offer no answer to this question. The data do indicate, however, the reflective subjects can perform more detailed feature analysis when forced to do so in two seconds than the impulsives can do when given ten seconds.

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. The 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.

Finally, a general finding that should be emphasized concerns the efficiency of visual recognition memory. Given no special instructions, even the impulsive subjects with four seconds exposure (the worst group) correctly recognized 78% (18.82/24) of the stimuli even when the correct and incorrect test stimuli differed in only one distinctive feature. Performance under normal or "standard" recognitions (Condition DO) for all subjects was 96% (23.05), a figure in line with the results from studies which have used as many as 600 (Shepard, 1967) or even 2,500 highly differentiated pictorial stimuli (Conezio, Standing, & Haber, 1970). That the process of recognition memory at variable exposure times is visual, and not verbal, can be inferred from the equally high performance of the sample as a whole in Condition 4FD (97%).

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 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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Vita

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