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HUE LABELING AND DISCRIMINATION IN CHILDREN WITH PRIMARY READING RETARDATION.

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DESCRIPTORS- *READING RESEARCH, *PERCEPTION, *RETARDED READERS, *MALES, INTERMEDIATE GRADES, MATCHED GROUPS, VISUAL DISCRIMINATION, VISUAL PERCEPTION, NEUROLOGICALLY HANDICAPPED, UNIVERSITY OF MICHIGAN,

THE LABELING AND DISCRIMINATION OF COLORS WERE STUDIED IN CHILDREN WITH PRIMARY READING RETARDATION AND IN A MATCHED GROUP OF NORMAL CHILDREN. TEN MALE STUDENTS IN MICHIGAN REPRESENTING AN AGE RANGE OF 9 YEARS 10 MONTHS TO 14 YEARS 10 MONTHS WERE CHOSEN AS SUBJECTS. DEVELOPMENTAL, MEDICAL, EDUCATIONAL, NEUROLOGICAL, PSYCHIATRIC, AND PSYCHOMETRIC DATA WERE COLLECTED ON EACH SUBJECT. EITHER THE GATES READING TEST OR THE CALIFORNIA READING TEST WAS ADMINISTERED. EACH RETARDED READER WAS MATCHED WITH A NORMAL READER OF APPROXIMATELY THE SAME AGE AND INTELLIGENCE. THE SPECTRAL LOCATIONS OF BOUNDARIES BETWEEN COLOR CATEGORIES WERE COMPARABLE IN THE GROUPS. THE DISCRIMINATION FUNCTIONS OBTAINED FOR BOTH GROUPS WERE BETTER THAN THOSE PREDICTED. THE NORMAL GROUP PERFORMED SIGNIFICANTLY MORE ACCURATELY THAN THE RETARDED READERS. BOTH GROUPS SHOWED A POSITIVE CORRELATION BETWEEN PREDICTED AND OBTAINED DISCRIMINABILITY SCORES. TABLES AND REFERENCES ARE INCLUDED. (BK)

Hue Labeling and Discrimination in Children with Primary Reading Retardation[1, 2]

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The labeling and discrimination of colors were studied in children with primary reading retardation and in a matched group of normal children. The spectral locations of boundaries between color categories were in general comparable in the two groups. Predictions of hue discriminability, based on the slopes of the color labeling functions across the spectrum, were the same for both groups. Obtained discrimination functions for both groups were better than those predicted, with the normal group performing significantly more accurately than the group of retarded readers. Both groups showed a moderately high, positive correlation between predicted and obtained discriminability scores.

The syndrome of primary reading retardation has been described by Rabinovitch as a condition in which

> capacity to learn to read is impaired without definite brain damage being suggested in the case history or upon neurologic examination. The defect is in the ability to deal with letters and words as symbols, with resultant diminished ability to integrate the meaningfulness of written material. The problem appears to reflect a basic disturbed pattern of neurologic organization [1962, p. 74].

This classification distinguishes the condition from the remaining disorders in which specific etiology can be demonstrated or inferred (Gofman, 1965; Rabinovitch, 1959).

Although the reading disorder itself is of primary clinical interest, investigation of the condition since it was recognized has revealed that it is usually accompanied by a variety of abnormalities. Taken together, these comprise a consistent syndrome, delineated by Silver and Hagin (1960) as follows: right-left discrimination defects, abnormal arm elevation test (Schilder), somewhat immature postural reflexes, visual-motor immaturity with specific difficulty in figure-ground perception, frequent inability to grasp temporal relationships of sounds, and abnormal body image. The vast majority of research devoted to this problem in the past has been undertaken in the effort to clarify the relationship between the reading problem and its associated abnormalities. The parallels between this condition and the adult "acquired dyslexias" have not been overlooked, and the attention of neurologists continues to focus on evidence implicating abnormalities in parietal-occipital function (Benton, 1962: Cohn, 1961; Critchley, 1961; Geschwind, 1962; Whitsell, 1965).

Since the deficiency in "dealing with symbols" is so prominent, there has been no lack of investigation into this facet of the disorder. Orton (1937), who had coined the term "strephosymbolia" to denote the common tendency to reverse the spatial orientation or sequence of letters, believed that the disorder results from a failure to repicture the exact order of the constituent letters of a word. This explanation has been elaborated by Money:

> In developmental cognition, the human child makes two achievements simultaneously. On the one hand he builds up an inventory of what, among the parade of patterns of figures against backgrounds that reach his retina, must be classified as separate entities. On the other hand he builds up paradigms of how many different sensory patterns an object may make and still be the same object. Thus, a cup is a cup whether it is sitting or hanging, upright or inverted, seen from below or above one's eyes, with the handle to the left, right, front or rear, and even when it is lying smashed in pieces. Not so with the characters of the alphabet like b and d, p and q! And not so with the arrangement of the alphabetic characters in words. Their positional sequence and not their mere presence is then of utmost importance: w-o-r-d-y is not the same as r-o-w-d-y, but they may be to a dyslexic, since the same five letters are in each. Success with the alphabet in reading and writing requires the reader to override the principle of constancy that usually applies [1962, p. 18].

The views of Orton and Money both provide that the disorder affects not peripheral visual mechanisms but rather the subsequent central processes set in motion by retinal activity. However, it has not been shown conclusively that the disorder is "not one of sensory reception but of memory [Orton, 1937]." And, indeed, there is evidence from psycholinguistic and psychophysical research that such a dichotomy is not easily made. A brief consideration of one facet of this evidence should indicate why we believe the sensory capacity of the primary reading retardate deserves further study.

Psycholinguistic studies of "categorical perception" have shown that "stimuli along certain continua are associated with behavior in a discontinuous fashion [Kopp & Lane, 1967]." An illustration of this phenomenon is given in Figure 1. In an experiment by Liberman et al. (1961) Ss were presented with a

Insert Figure 1 about here

series of syllables which were synthesized electronically to consist of two resonance bands (formants) separated by a variable period of time. By changing the time of onset of the second formant with respect to the first in discrete steps, it was possible to create a series of sounds whose opposite extremes were perceived as the phonemes /do/ and /to/. When the entire series was presented this continuum of sounds was perceived categorically; the Ss identified each sound consistently as either /do/ or as /to/. As shown in the bottom graph of Figure 1, "instead of finding a continuous scale in which, say, the first bit of phonic substance was heard as /do/ 100% of the time, the second 85%, the third 70% and so forth, we find almost perfect polarity [Lane, 1966, p. 218]."

In a second part of the experiment, triads of syllables were presented with the forms ABA, ABB, BAA, and BAB (in which A and B are different syllables selected from the continuum). The Ss were asked to state whether the third syllable in each triad was the same as the first or the second. When the members of a pair differed by some fixed delay in onset time of the second formant, and pairs from all regions of the continuum were presented, it was found that the probability of making a correct response was maximal in the region of the naming boundary previously defined by the Ss' stimulus identifications. In other words, the Ss were best at detecting small differences between sounds precisely at the point along the continuum where a difference was, for them, linguistically significant. This "enhancement of discrimination" at the boundary between naming categories has been found to coincide with arbitrary labeling boundaries produced by simple conditioning procedures in the laboratory (Cross, Lane, & Sheppard, 1965).

These findings have been extended in experiments on labeling and discrimination with respect to visual stimuli. Examining the two kinds of functions for the hue continuum, Lane (1966) noted that color labeling is also polarized (probabilities tend toward zero or one) and--more important--that color discrimination is best just at the boundaries between color categories (see Figure 2). If

Insert Figure 2 about here

hue discrimination is governed then by the phenomenon of "categorical perception," and if the color categories vary from one language community to the next (as all the evidence indicates--e.g., Ray, 1953), then hue discrimination must also vary across disparate language communities, and its status as an indicator exclusively of peripheral visual mechanisms (Ruch, 1965) is called into question.

Lane and Kopp explored the latter possibility, that color discrimination depends on color categorizing, by examining the color labeling and discrimination of monolingual speakers of Tzotzil, a Mexican-Indian language quite different from English. Figure 3 illustrates initial findings from the research still in progress. It appears that color labeling differences between this Indian culture (Figure 3, top) and our own (bottom) are marked. Furthermore, three

Insert Figure 3 about here

peaks in discrimination, corresponding to three color name boundaries, are obtained from the Tzotzil observers, in contrast with four for English observers. Accordingly, hue discrimination is found to differ across the two language groups, in support of the hypothesis that linguistic as well as unconditioned biological factors regulate this indicator of perceptual process.

The distinction between peripheral and central impairment may also be called into question on theoretical grounds germane to the present investigation. In the theory of signal detection (Green & Swets, 1966; Swets, 1964), the "fundamental detection problem" is one in which a point of light is presented for a brief interval against an illuminated background. The observer is required to state whether, during a given interval, the point of light was or was not present. The observer is told in advance what percentage of test intervals will contain a "signal" (the target point of light). He is also told how much money he will make or lose for correct and incorrect responses. According to the theory, the observer tends to select a detection criterion (some level of intensity of the signal) yielding the maximal payoff; he does not behave independent of probabilities and payoffs, as though his choice were determined by a fixed physiological threshold. Variation of the observer's knowledge of probabilities, the payoff matrix and the background illumination was systematically carried out in numerous experiments and the findings substantiate the hypothesis. The investigators conclude:

The main thrust of this conception, and the experiments that support it, is that more than sensory information is involved in detection. It may also be contended that what we have been referring to as a detection process is itself a perceptual process. Certainly, if perceptual processes are to be distinguished from sensory processes on the grounds that the former must be accounted for in terms of events occurring within the receptor system, then the processes with which we have been concerned qualify as perceptual processes. Since, in detecting signals, the observer's detection goal and the information he possesses about probabilities and values play a major role, we must assume either that signal detection is a perceptual process, or that the foregoing distinction between sensory and perceptual processes is of little value [Swets, 1964, p. 51].

In the light of both psycholinguistic and psychophysical research, then, it seems advisable not to assign the etiology of primary reading retardation to central as opposed to sensory factors, but rather to examine even the most basic perceptual processes in the population with this disorder. The present study is an investigation of hue labeling and discrimination in children with primary reading retardation and in normal children. The study draws from the theory of categorical perception expectations about the form and relations of the functions relating labeling and discrimination to wavelength. It draws from the theory of signal detection techniques for assessing these types of behavior and inferences concerning the outcome. The null hypothesis under examination is that normal and reading retarded children will not differ significantly in the characteristics of their hue labeling and discrimination.

Method

Subjects

Because of the difficulty of clearly identifying the child with primary reading retardation, only those Ss who met generally accepted diagnostic criteria were accepted. Ten males, whose ages ranged from 9 years 10 months to 14 years 10 months, were selected from the Day School at Hawthorn Center in Northville, Michigan. In every case the personal file was examined and screened for the following information:

(a) Developmental history: Gestational events, perinatal events, developmental milestones, evidence of maturational lag, family makeup and positive family history of reading disorders; (b) Medical history: Disease history, specific findings in medical workups, hospitalizations, medical treatment; (c) Educational history: Specific strengths and weaknesses, behavioral problems in school, failed grades, school referrals and remediation, response to special efforts; (d) Neurological workup: Abnormalities in gait, station, reflexes, sensation, cortical sensation, cranial nerves, cerebellar function, "soft-signs"; (e) Psychiatric workup: Evaluation of anxiety, guilt, sense of inferiority and frustration; conceptual difficulty with respect to orientation, abstraction, time, size, number, direction; evidence for primary psychiatric disturbance, therapeutic efforts and response; (f) Psychometrics: The Wechsler Intelligence Scale for Children (required), the Gates or California Reading Test.

This screening procedure was designed to exclude from the study any S whose reading disorder might reasonably be explained in any way other than as a primary retardation (Gofman, 1965).

Since the importance of maturational and intellectual determinants in achieving symbolization is well known (Benton, 1962), each of the retarded readers was matched against a normal reader of approximately the same age and intelligence. The latter group was drawn from the student population of the University School in Ann Arbor. A comparison of the two groups is given in Table 1.

Insert Table 1 about here

Apparatus

Monochromatic stimuli were generated by passing "white" (3200° K) light through a continuous interference filter (Schott type Veril S-60; Fish-Schurman, Inc.) and thence through a 1 mm vertical slit. This procedure produces relatively intense spectral stimuli with a half band-width of approximately 12 mμ over the entire range of visible wavelengths. Stimulus intensity was measured at the position of the S's eyes using a spot photometer. Intensities ranged monotonically from 62 db to 86 db, (re: 10^{-10} Lamberts) at the shortest and the longest wavelength, respectively. Wavelength changes were produced by traversing the filter horizontally across the slit, the peak wavelength value in millimicrons being linear with the transverse distance in millimeters. Ss were seated in a darkened room, approximately 3 ft. from a ground glass screen. The stimuli were projected onto the observe side of the screen through the lens system of a standard classroom projector. The resulting stimulus consisted of a vertical rectangle, the dimensions of which were approximately 3/4" by 5/16". The stimulus surround was rendered completely black by masking the screen with black plasterboard. All stimulus events were recorded on an 8 channel recorder.

Procedure

Hue labeling. Discrete wavelength values, ranging from 430 to 640 mμ in 15 mμ steps were presented tachistoscopically at 7.5 sec. intervals (stimulus duration .75 sec.) according to random protocol. A complete testing series was completed after the S had viewed each wavelength a total of ten times. Each stimulus was preceded by a statement from the E assigning a color name to it, and the S was instructed to indicate, by pressing one of two keys, whether he agreed or disagreed with the name assigned to the stimulus. Ss were told that, in the past, other Ss had tended to agree about half of the time, and disagree about half of the time, but that there were no right or wrong answers. For each wavelength, the name preceding stimulus presentation on five occasions was the common English color name; the common English name of the nearest adjacent color category was given for the five other presentations.

AX discrimination. In this section of the experiment, Ss were presented pairs of stimuli whose members were either the same wavelength or were separated by 20 mμ. The Ss were instructed to indicate by pressing one of two keys whether the colors were identical or not. The wavelength interval chosen for this experiment, which was larger than the 14 mμ used by Kopp and Lane (1967) was adopted after early trials with retarded readers indicated a failure to detect consistently any interval at appreciably lower values. Stimulus duration was again .75 sec. The delay from the end of the second stimulus of one pair until the first stimulus of the following pair was 5 sec. As in the labeling experiment, each stimulus point (wavelength) was presented ten times, with an interval being present five times and no interval present five times. The Ss in both experiments rested for approximately 2 min. after each set of 30 test presentations.

Results and Discussion

Color labeling

Figure 4 presents the average labeling and discriminability measures as a function of wavelength for the retarded readers. Figure 5 gives the corresponding

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Insert Figures 4 & 5 about here

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findings for normal readers. The "per cent positive identification" is equal to the number of times S said "yes" to the color name given him prior to presensation of the wavelength shown on the abscissa, divided by the number of times he heard that same name at that same wavelength. Transition points between identification categories are marked and the corresponding wavelengths are listed in Table 2. Except for the disparity at the Violet-Blue boundary, a result of a low frequency of "yes" responses to the name "Violet" by the normal group, the boundaries in the two groups are virtually identical.

Insert Table 2 about here

Discriminability (predicted)

We may derive a predicted discriminability function from the labeling measures based on the extreme assumption that wavelength differences are detected only to the degree that the difference is linguistically significant. More precisely, two hues will be discriminated to the degree that they are labeled differently. The formula for computing the predicted level of discrimination, given the labeling probabilities associated with each of the two stimuli in the pair, was as follows (Liberman, et al., 1961):

$$p\ corr_{AB} = .5 + \frac{[(p\ R_1 - p'R_1) + (p\ R_2 - p'R_2) + (p\ R_3 - p'R_3) + \ldots + (p\ R_n - p'R_n)]}{4}$$

Where $p\ corr_{AB}$ = The predicted relative frequency of correct discriminations between stimuli A and B.

$p\ R_n$ = The relative frequency with which a given labeling response (R_n) is assigned to stimulus A.

$p'R_n$ = The relative frequency with which a given labeling response (R_n) is assigned to stimulus B.

It follows from this formula that where there is no change in color naming across the interval, the S will do no better than chance at detecting the interval. It will be seen from Figure 6 that discriminative functions predicted in this way match the obtained functions well in both groups, but tend to fall below them.

Insert Figure 6 about here

This means that both normal and retarded children utilize somewhat more information than merely the linguistic labels of the colors when they are attempting to distinguish them. There was no differencebetween the two groups with respect to the predicted levels of discrimination (Table 3).

Insert Table 3 about here

Discriminability (obtained). Average discriminability was plotted for nine of the ten participating pairs of Ss. The normal S in pair nine stated at the end of this part of the test that he might have confused the response buttons. Since his record also revealed highly inconsistent responding, his data were excluded from the analysis of this part of the experiment. Figure 7 is a

Insert Figure 7 about here

comparison of the obtained discriminability for the two groups, at the 20 mμ interval. On the average, the normal group did better than the retardate group (see Table 4). A t-test for matched pairs (Guilford, 1965) showed the difference to be significant at the .05 level ($t=2.8$, $df=8$, two-tailed).

Insert Table 4 about here

Detailed inspection of the results for the normal group reveals a possible improvement of discriminability with age, but the sample is too small to establish this trend. There is no evidence of a similar trend in the retardate group, where the third lowest discriminability score was obtained by the S who was the oldest and had the highest Performance IQ. A comparison of the present findings with those of Kopp and Lane (1967) reveals that the children tested with wavelength intervals of 20 mμ achieved an accuracy of discrimination approaching that of college students tested at wavelength increments of 14 mμ. It may be that this increase in resolving power with age reflects the functional development of the visual system, although methodological differences between the two studies are more probably implicated.

Although the mean accuracy of discrimination was higher for the normal than the reading-retarded Ss, the associated variances were almost identical (Table 5).

Insert Table 5 about here

Finally, the product-moment correlation between predicted and obtained discrimination for both groups was calculated. Moderately high, positive correlations were found, with the normal group having on the average a higher correlation between predicted and obtained performance (Table 6). This means that both groups tend to categorize in part when making discriminative judgments, and normals somewhat

Insert Table 6 about here

more so than retardates, although the latter difference is not statistically reliable. The finding of reliably inferior color discrimination among the reading retarded Ss is open to several interpretations which may be evaluated by related kinds of experiments. It may be that children with primary reading retardation perform poorly on visual discrimination tasks in general--color or otherwise. Or, more broadly, primary reading retardation may be symptomatic of a discrimination defect extending beyond visual discrimination in these children.

Another approach to the interpretation of the present findings comes from the theory and methodology of Signal Detection. The experimental design utilized in this study is fundamentally analogous to that used in Signal Detection experiments on pair-matching, and certain inferences drawn from that theoretical framework may be applied here. In particular, we may say that the retarded readers behaved as if they had less usable information (a lower signal-to-noise ratio) than did the normal readers since the other determinants of detection behavior (knowledge of probabilities and the payoff matrix) did not differ between the two groups.

Footnotes

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Table 1

Psychometric Measures on Matched Pairs

of Normal and Reading Retarded Children

Match Pair No.	Subject Code	Age When Tested (Yr-Mo)	School Grade When Tested	W. I. S. C. Verbal	Performance	Full Scale	Stanford-Binet (Revised)	Date of Intelligence Test	Gates Oral Reading	Gates Arithmetic	Calif. Reading Test (Total)	Date of Reading Test
1	4806	9^{10}			104			8/66	1.9	3.5		8/66
	4812	9^{9}	4	91			117	4/66			2.7	3/66
2	4804	10^{3}		94	114	104		10/62	2.1	3.0		8/66
				86	90	87		7/65				
	4817	10^{6}	5				114	9/65			5.5	4/66
3	4829	10^{5}		89	99	93		11/65	2.3	3.5		1/67
	4814	11^{0}	5				113	3/66			3.9	4/66
4	4803	11^{2}		101	115			12/65	2.5	4.1		2/67
	4828	11^{9}	6				119	5/66			6.7	3/66
5	4815	12^{1}		81	92	85		2/65	2.0	3.0		10/66
	4810	11^{5}	5				98	9/65			2.8	3/66
6	4808	12^{8}		94	107	100		7/64	3.2	3.5		1/67
	4823	12^{5}	7	101	115	109		10/66			9.9	9/66
7	4832	13^{7}		91	104	97		10/65	3.8	3.8		8/66
	4818	13^{11}	8	114	107	112		12/65			10.2	9/66
8	4830	14^{4}		91	122	107		1/61	2.3	4.7		6/66
	4809	14^{3}	9	125	107	118		12/65			11.1	9/66
9	4801	14^{8}		94	104	99		5/66	3.5	4.7		1/67
	4820	15^{0}	9	111	101	107		3/66			10.1	9/66
10	4805	14^{10}		116	133	127		12/63	3.5	7.6		12/66
	4824	14^{8}	9	131	132	135		4/66			14.6	9/66

Table 2

Spectral Loci of Boundaries Between Categories in Color Identification by Normal and Reading Retarded Children

Color Categories	Boundary Loci (in mμ)	
	Normals	Reading Retarded
Violet-Blue	430	461
Blue-Green	493	492
Green-Yellow	567	569
Yellow-Orange	588	587
Orange-Red	609	608

Table 3

Average Predicted Accuracies of Hue Discrimination Based on the Hue Labeling of Normal and Reading Retarded Children

Pair Number	Normal	Retarded Reader	Difference
1	.59	.60	-.01
2	.61	.57	+.04
3	.59	.62	-.03
4	.63	.57	+.06
5	.60	.60	
6	.56	.62	-.06
7	.60	.61	-.01
8	.62	.62	
9	.60	.59	+.01
10	.58	.63	-.05
Mean	.60	.60	-.005
Std. Dev.	.002	.002	

Table 4

Average Obtained Accuracies of Hue Discrimination by Normal and Reading Retarded Children

Pair Number	Normal	Retarded Reader	Difference
1	.71	.79	-.08
2	.79	.66	+.13
3	.81	.67	+.14
4	.81	.76	+.05
5	.79	.74	+.05
6	.81	.74	+.07
7	.86	.85	+.01
8	.82	.73	+.09
9*			
10	.86	.71	+.15
Mean	.807	.739	+.068
Std. Dev.	.040	.058	.069

*See text

Table 5

The Variability, Across the Spectrum, in the Obtained Accuracy of Hue Discrimination in Normal and Reading Retarded Children

Pair Number	Normal	Retarded Reader	Difference
1	.029	.008	+.021
2	.019	.017	+.002
3	.019	.034	-.015
4	.026	.016	+.010
5	.015	.035	-.020
6	.025	.019	+.006
7	.018	.014	+.004
8	.039	.031	+.008
9	.013	.032	-.019
10	.028	.008	+.020
Mean	.023	.021	+.002
Std. Dev.	.0077	.0101	

Table 6

Product-Moment Correlations Between Predicted and Obtained Measures of Discrimination Accuracy in Hue by Normal and Reading Retarded Children

Pair Number	Normal	Retarded Reader	Difference
1	.53	.27	+.26
2	.62	.64	-.02
3	.70	.52	+.18
4	.45	.65	-.20
5	.39	.41	-.02
6	.50	.69	-.19
7	.56	-.005	+.57
8	.81	.61	+.20
9*			
10	.52	.68	-.16
Mean	.564	.495	+.069
Std. Dev.	.145	.216	

*See text

Figure Captions

Fig. 1. Identification and discrimination functions for an acoustic-phonetic continuum, illustrating categorical perception. (These functions for a representative S were redrawn from Liberman et al., 1961.)

Fig. 2. Averaged identification and discrimination functions for the hue continuum, illustrating categorical perception. A smaller difference in wavelength is detectable when the two hues are labeled differently. (From Lane, 1966.)

Fig. 3. The probability and latency of hue identification and the accuracy of hue discriminations in representative speakers of Tzotzil (top) and English (bottom). (From Kopp & Lane, 1967.)

Fig. 4. Hue identification (solid lines) and discrimination (broken line) by children with primary reading retardation. Each point represents the mean of ten responses by each of ten or of nine Ss, respectively.

Fig. 5. Hue identification (solid lines) and hue discrimination (broken lines) by normal children matched to those with reading retardation (Fig. 4). Each point represents the mean of ten responses by each of ten or of nine Ss, respectively.

Fig. 6. A comparison of the hue discrimination functions obtained (solid lines) from the normal and reading retarded children with those predicted from their respective identification functions.

Fig. 7. Hue discrimination functions for normal children (solid line) and matched reading retarded children (broken line). The discrimination functions presented in Figs. 4 and 5 have been redrawn here to facilitate comparison.

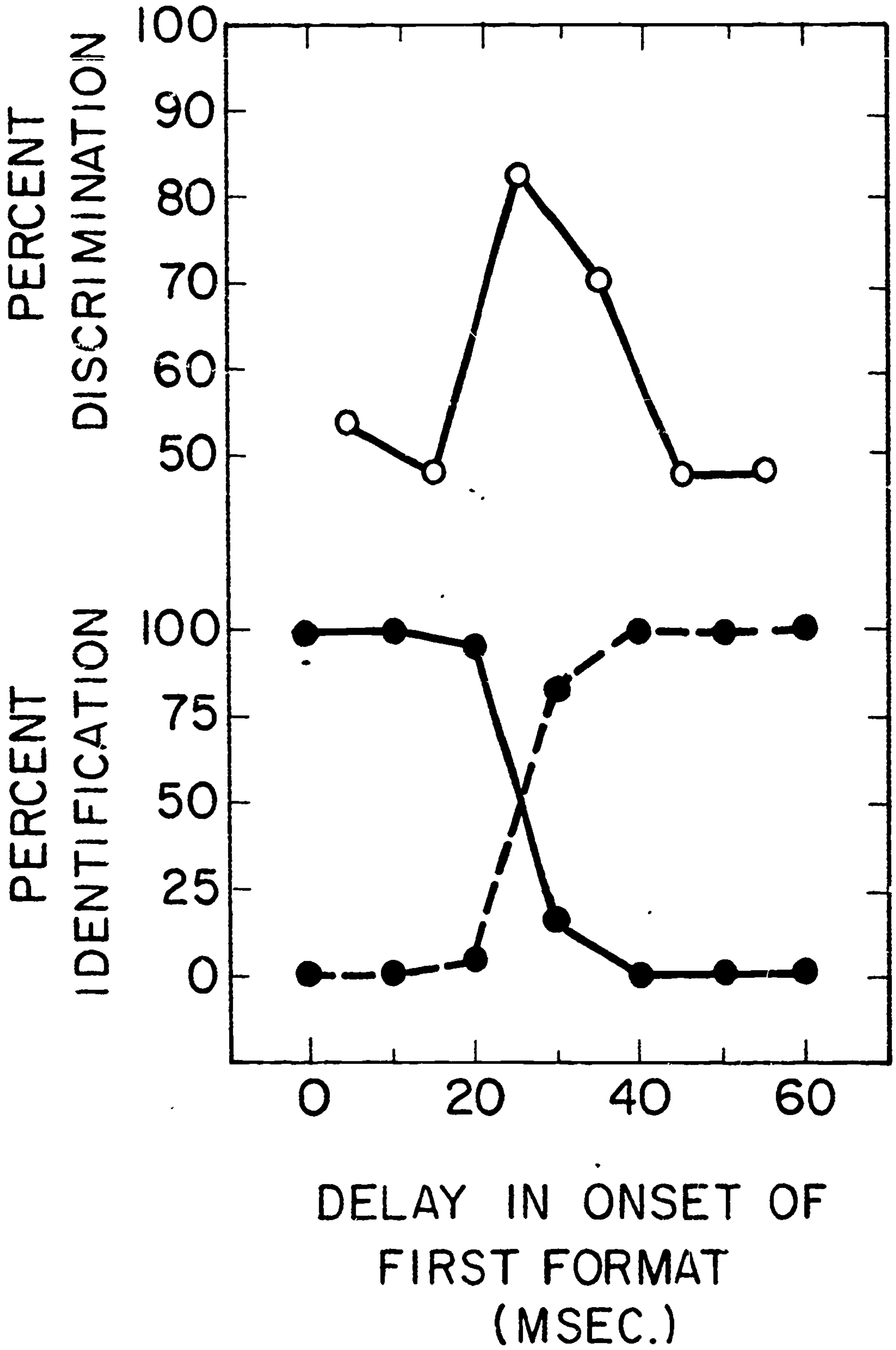

PERCENT DISCRIMINATION
100
90
80
70
60
50
PERCENT IDENTIFICATION
100
75
50
25
0
0
20
40
60
DELAY IN ONSET OF FIRST FORMAT (MSEC.)

Figure 1

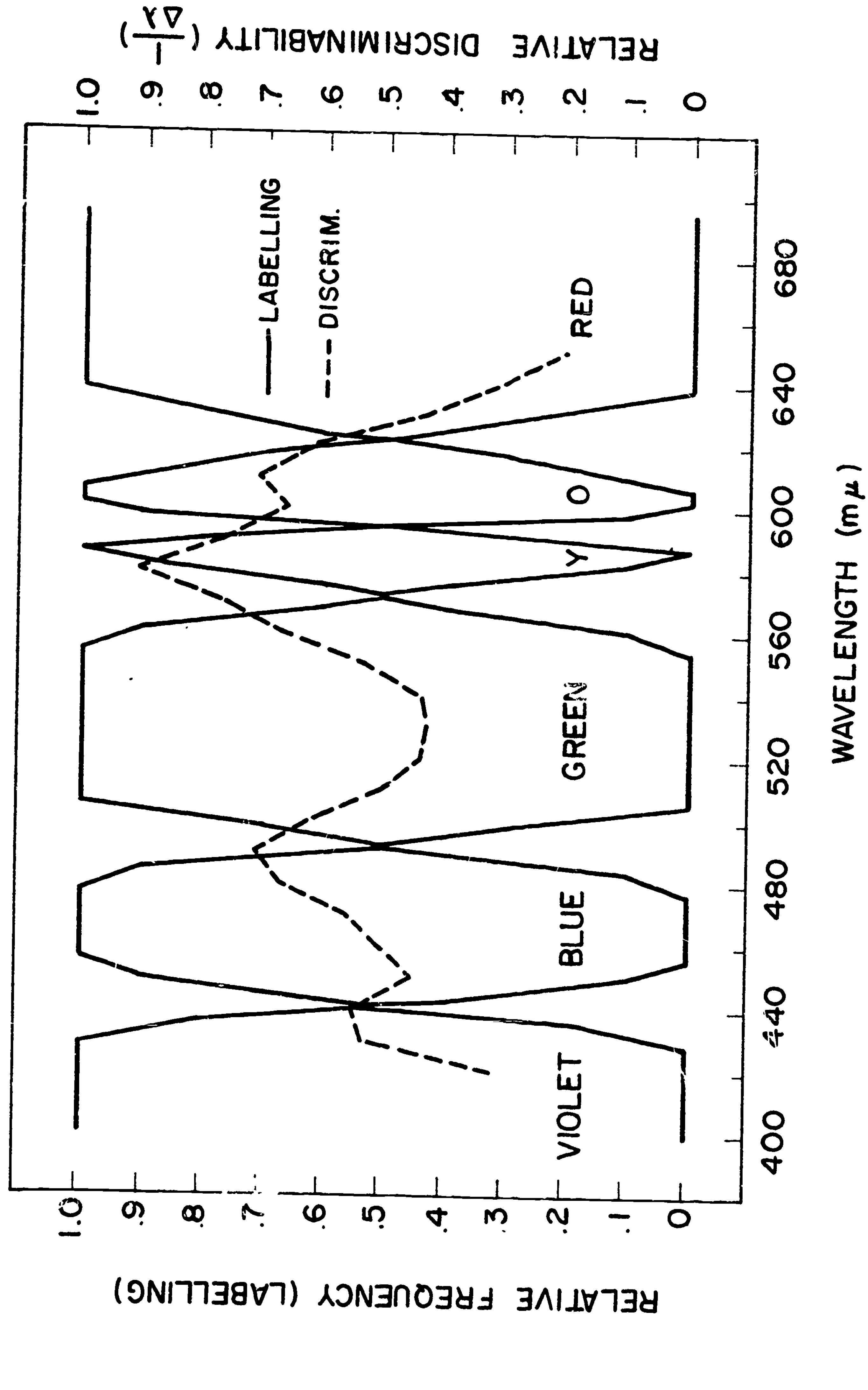
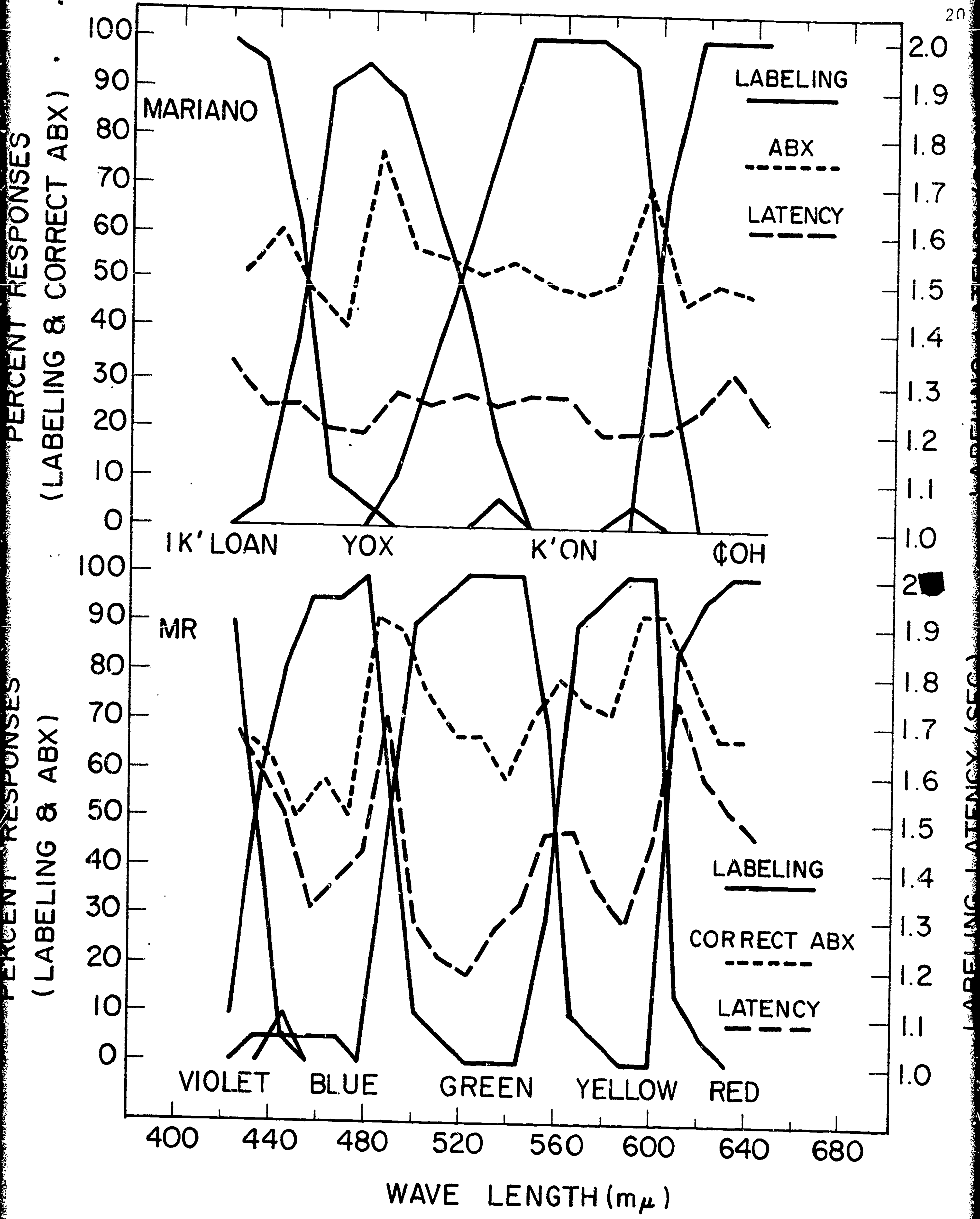

RELATIVE DISCRIMINABILITY ($\frac{1}{\Delta\lambda}$)
1.0 .9 .8 .7 .6 .5 .4 .3 .2 .1 0
LABELLING
DISCRIM.
VIOLET
BLUE
GREEN
Y
O
RED
400 440 480 520 560 600 640 680
WAVELENGTH (mμ)
1.0 .9 .8 .7 .6 .5 .4 .3 .2 .1 0
RELATIVE FREQUENCY (LABELLING)

Figure 2



PERCENT RESPONSES (LABELING & CORRECT ABX)
MARIANO
LABELING
ABX
LATENCY
IK'LOAN
YOX
K'ON
¢OH
PERCENT RESPONSES (LABELING & ABX)
MR
LABELING
CORRECT ABX
LATENCY
VIOLET
BLUE
GREEN
YELLOW
RED
400
440
480
520
560
600
640
680
WAVE LENGTH (mμ)

Figure 3

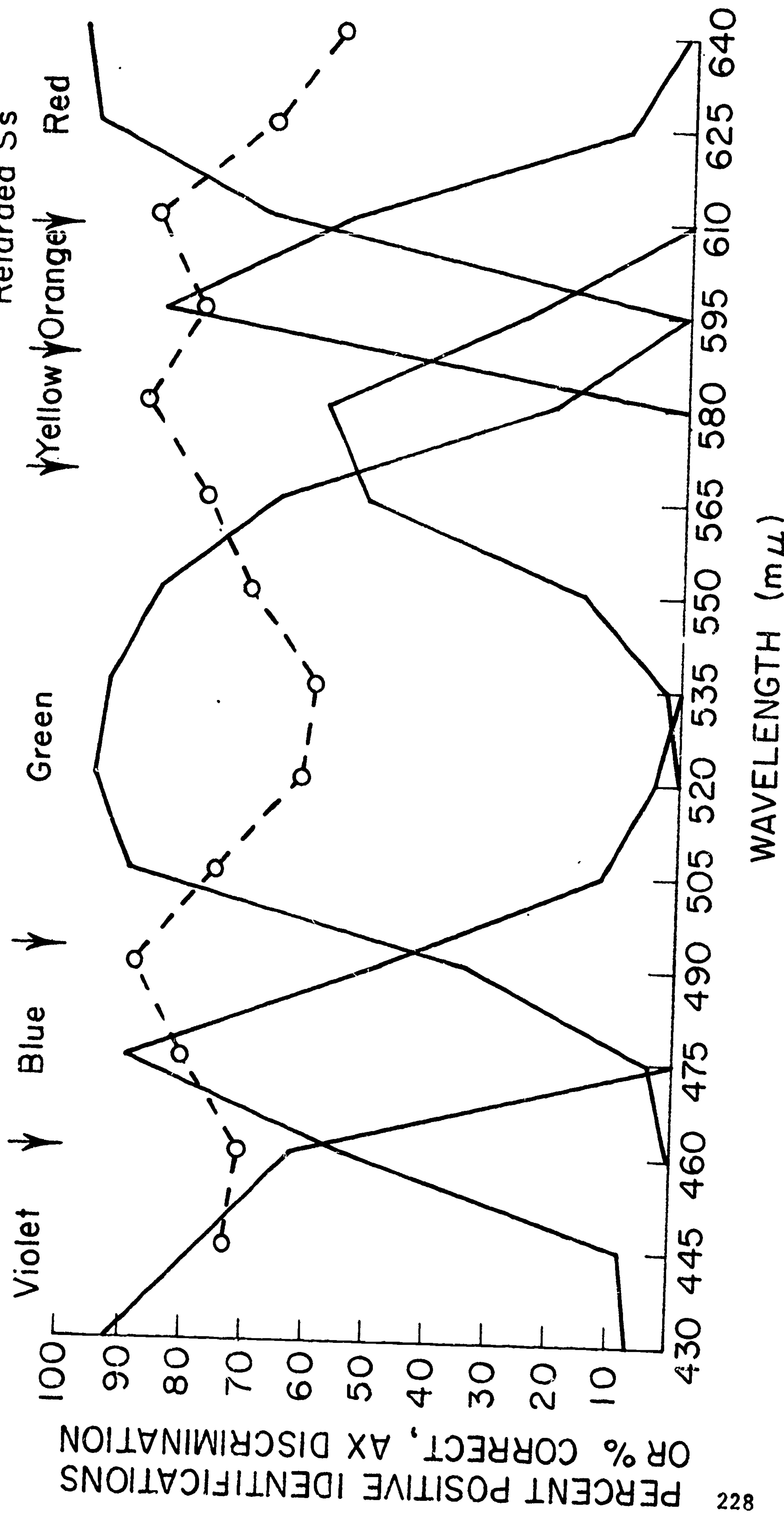

Retarded Ss
Violet
Blue
Green
Yellow
Orange
Red
PERCENT POSITIVE IDENTIFICATIONS OR % CORRECT, AX DISCRIMINATION
100
90
80
70
60
50
40
30
20
10
430
445
460
475
490
505
520
535
550
565
580
595
610
625
640
WAVELENGTH (mμ)

Figure 4

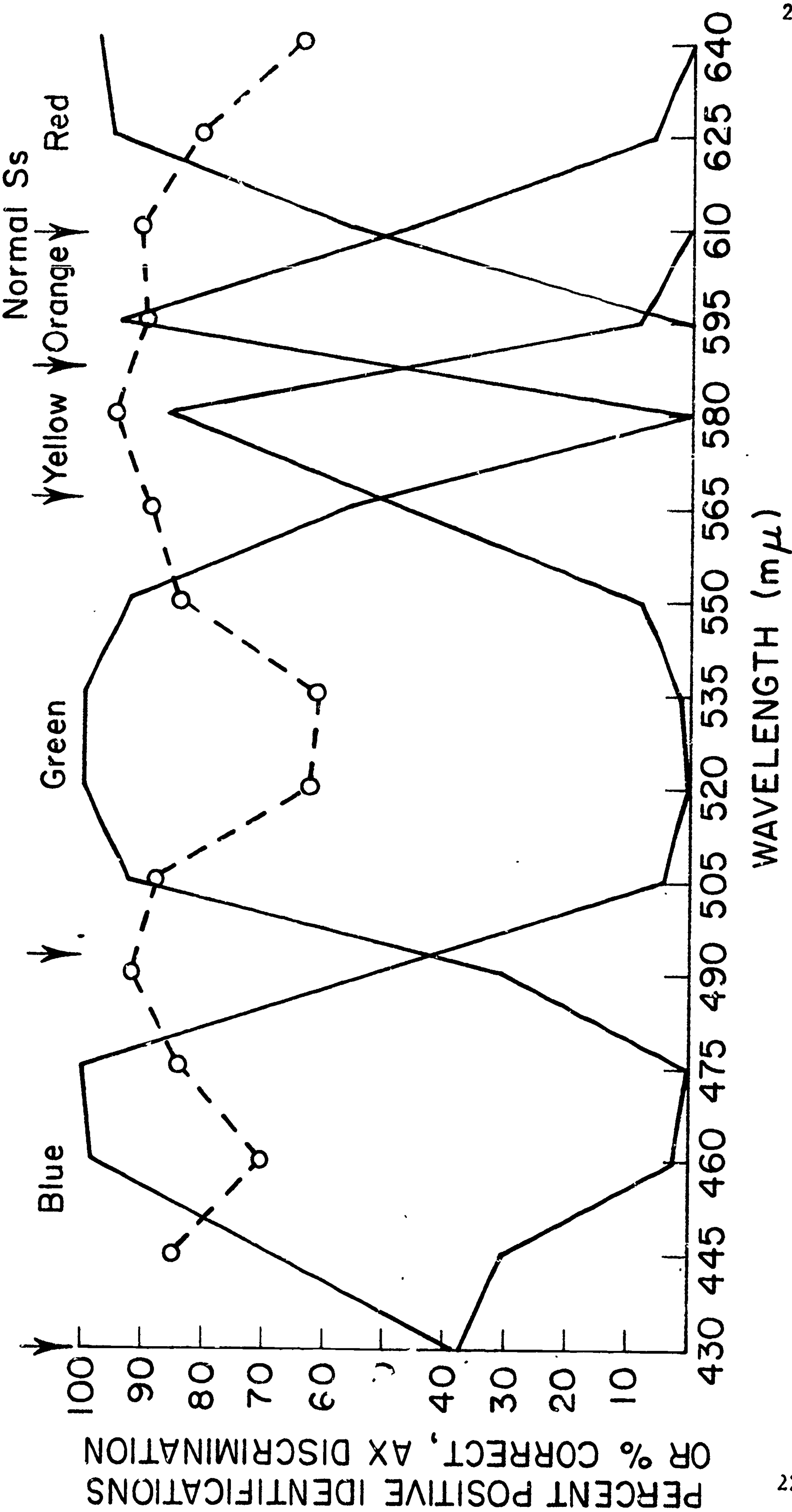

Blue
Green
Yellow
Orange
Normal Ss
Red
430 445 460 475 490 505 520 535 550 565 580 595 610 625 640
WAVELENGTH (mμ)
100 90 80 70 60 40 30 20 10
PERCENT POSITIVE IDENTIFICATIONS
OR % CORRECT, AX DISCRIMINATION

Figure 5

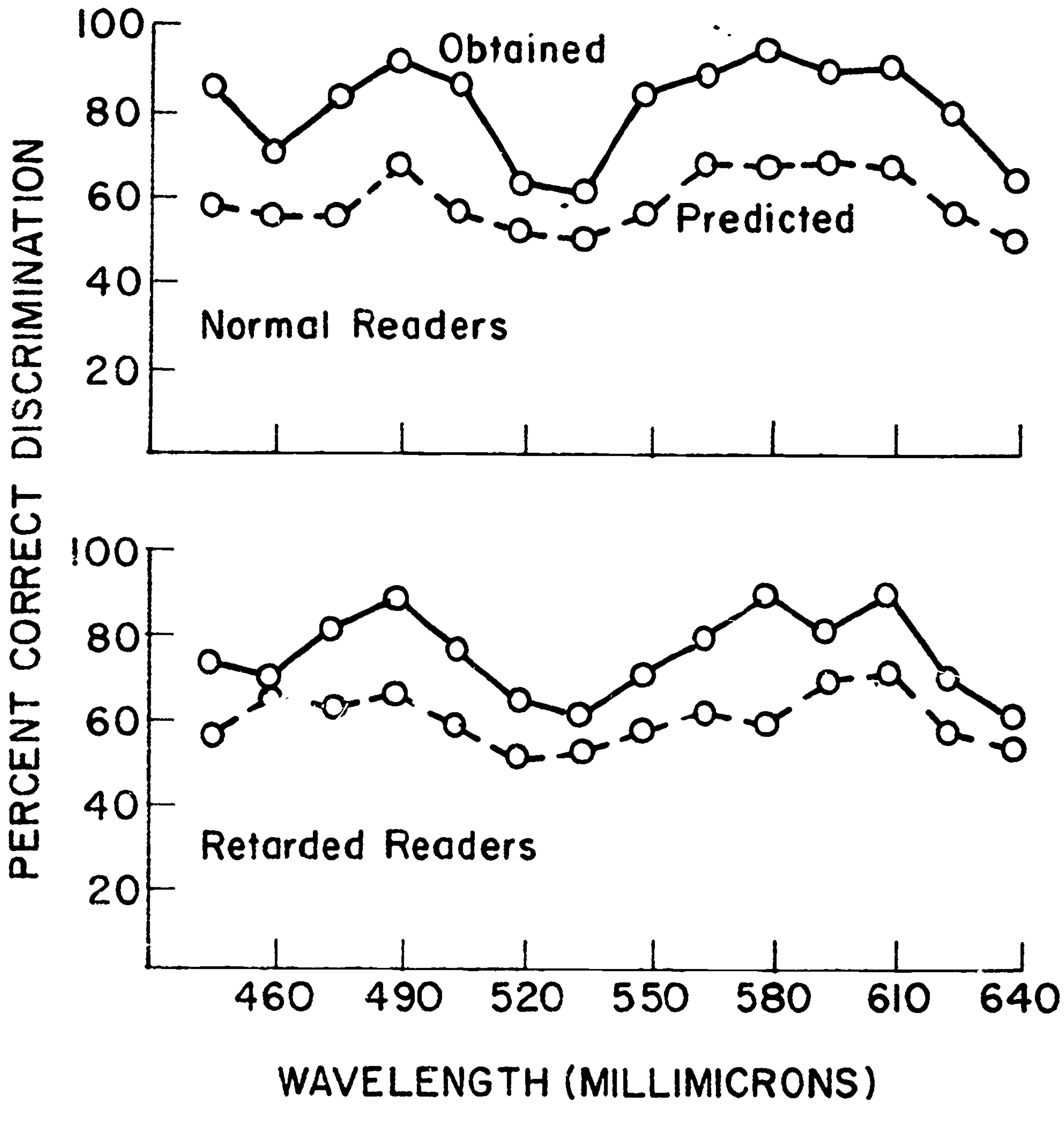

100
80
60
40
20
Obtained
Predicted
Normal Readers
PERCENT CORRECT DISCRIMINATION
100
80
60
40
20
Retarded Readers
460
490
520
550
580
610
640
WAVELENGTH (MILLIMICRONS)

Figure 6

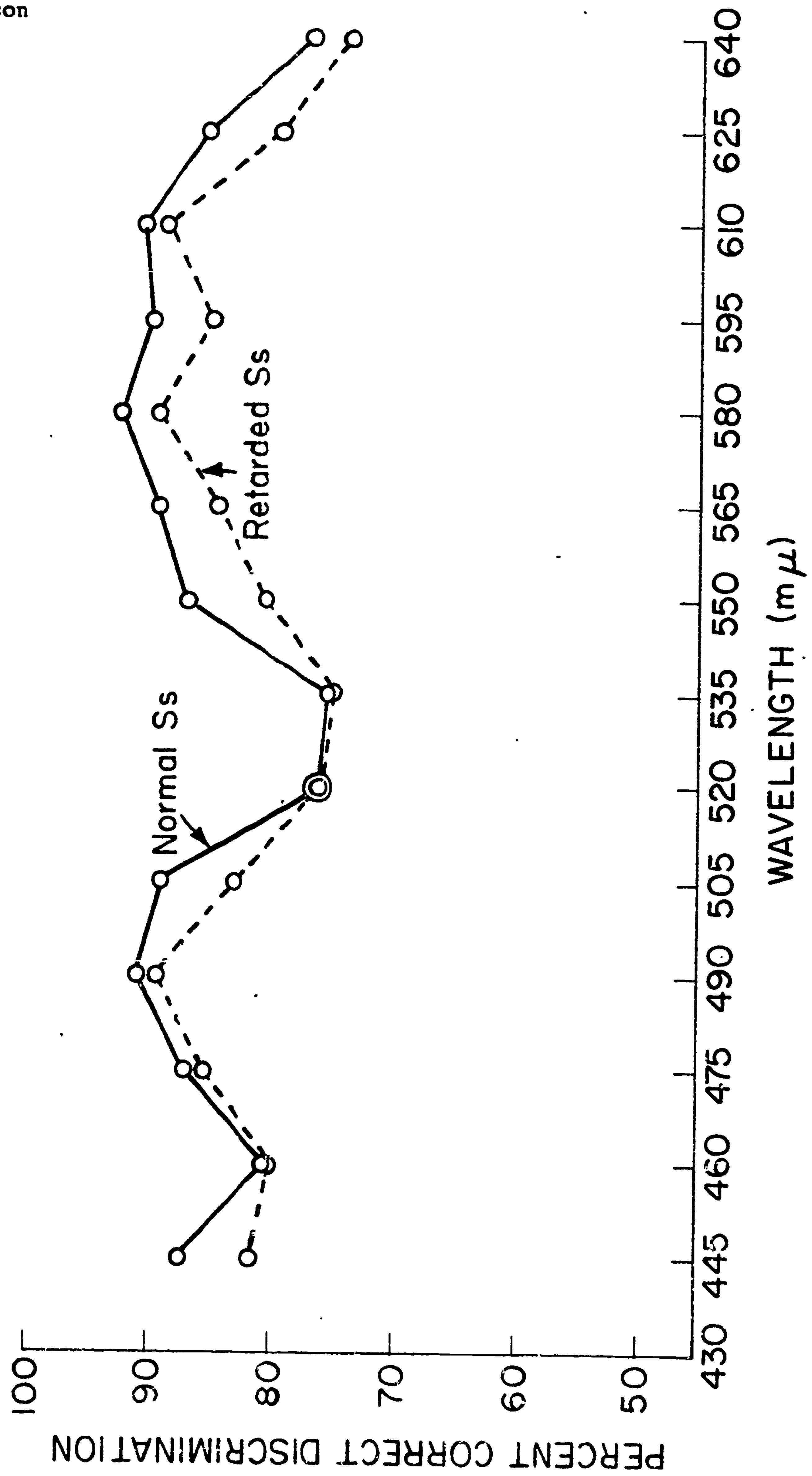

PERCENT CORRECT DISCRIMINATION
100
90
80
70
60
50
430
445
460
475
490
505
520
535
550
565
580
595
610
625
640
WAVELENGTH (mμ)
Normal Ss
Retarded Ss

Figure 7

Group B: Language Acquisition

The papers presented in this section can be grouped by the strategies used to explicate the process of language acquisition.

McNeill's papers represent a continuation of his concern with linguistic universals. He explores the implication of these universals for a theory of innate language capacity.

The papers of Barritt, Semmel, Weener, Bennett, Perfetti, Lifson and Sitko all use the technique of contrasting two or more definably different samples of language users. Differences in functioning are highlighted by this procedure and their implications for language acquisition are discussed.

Prentice focuses upon the well-known phenomenon of word associations. She demonstrates a relationship between earlier work in this area and the selection of words in experimentally manipulated sentence frames.

Barritt's paper on "Intelligence tests and educationally relevant measurements" argues for the value of studies like those carried out and reported in this section. He feels they are of mutual benefit to the psychologist and the educator.

hue discrimination is governed then by the phenomenon of "categorical perception," and if the color categories vary from one language community to the next (as all the evidence indicates--e.g., Ray, 1953), then hue discrimination must also vary across disparate language communities, and its status as an indicator exclusively of peripheral visual mechanisms (Ruch, 1965) is called into question.

Lane and Kopp explored the latter possibility, that color discrimination depends on color categorizing, by examining the color labeling and discrimination of monolingual speakers of Tzotzil, a Mexican-Indian language quite different from English. Figure 3 illustrates initial findings from the research still in progress. It appears that color labeling differences between this Indian culture (Figure 3, top) and our own (bottom) are marked. Furthermore, three

Insert Figure 3 about here

peaks in discrimination, corresponding to three color name boundaries, are obtained from the Tzotzil observers, in contrast with four for English observers. Accordingly, hue discrimination is found to differ across the two language groups, in support of the hypothesis that linguistic as well as unconditioned biological factors regulate this indicator of perceptual process.

The distinction between peripheral and central impairment may also be called into question on theoretical grounds germane to the present investigation. In the theory of signal detection (Green & Swets, 1966; Swets, 1964), the "fundamental detection problem" is one in which a point of light is presented for a brief interval against an illuminated background. The observer is required to state whether, during a given interval, the point of light was or was not present. The observer is told in advance what percentage of test intervals will contain a "signal" (the target point of light). He is also told how much money he will make or lose for correct and incorrect responses. According to the theory, the observer tends to select a detection criterion (some level of intensity of the signal) yielding the maximal payoff; he does not behave independent of probabilities and payoffs, as though his choice were determined by a fixed physiological threshold. Variation of the observer's knowledge of probabilities, the payoff matrix and the background illumination was systematically carried out in numerous experiments and the findings substantiate the hypothesis. The investigators conclude: