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Affective Discrimination of Stimuli that cannot be Recognized
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lag, Berlin, 1978)] has reviewed studies on color-selective spatial adaptation.
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7. Gratings of 8 cycle/deg were used, for these appeared to produce particularly strong adaptation. Such gratings approach the acuity limit of the short-wavelength pathway, which has poor spatial resolution [W. S. Stiles, *Doc. Ophthalmol.* **3**, 138 (1949)]. Studies reviewed by Brindley suggest that this pathway might more readily adapt to fine than to coarse spatial configurations [G. S. Brindley, *Physiology of the Retina and Visual Pathway* (Arnold, London, 1970), pp. 241-244].
8. C. F. Stromeyer III *et al.*, *Sens. Processes* **2**, 248 (1978).
9. C. F. Stromeyer III, R. E. Kronauer, J. C. Madsen, "Responses of short-wavelength cone pathways to different spatial frequencies," in preparation.
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12. G. Wyszecki and W. S. Stiles, *Color Science: Concepts and Methods, Quantitative Data and Formulas* (Wiley, New York, 1967), p. 579.
13. Both observers reported that when the red test pattern was presented in this flashed mode, the pattern appeared neither as a flash nor as a change of hue. The predominant appearance of the red grating at threshold was a pattern of just-visible vertical stripes. Additional experiments in which the mean spatial radiance of the red stimuli was constant gave results similar to those reported here; that is, the presence of the violet adapting grating did not affect the visibility of the red test grating.
14. D. M. Green and J. A. Swets, *Signal Detection Theory and Psychophysics* (Wiley, New York, 1966). We used a rating method, and d' was calculated from a maximal likelihood estimation (C. F. Stromeyer III, S. Klein, C. E. Sternheim, *Vision Res.* **17**, 603, 1977).
15. Results similar to those in Fig. 2 were also obtained with two observers using a field 8° in diameter with the central 1.5° occluded. The observer fixated the center of the field. The central region was occluded so that the observer could not detect the red grating with the blue-blind central area of the fovea [G. Wald, *J. Opt. Soc. Am.* **57**, 1289 (1967)], which is presumably not strongly adapted by the violet adaptation grating.
16. For this experiment the mean spatial radiance of the violet light was 8.62 log quanta deg^{-2} sec^{-1}.
17. Interocular transfer of less than 10 percent was obtained with another observer. Adapting and test gratings were 4 cycle/deg and were presented in alternation.
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20. R. L. DeValois in *Handbook of Sensory Physiology*, vol. 7, part 3, *Central Processing of Visual Information A: Integrative Functions and Comparative Data*, R. Jung, Ed. (Springer-Verlag, Berlin, 1973).
21. The yellow-green field was neglected in determining the contrast of violet test gratings, for the Π_3 mechanism is ~ 20 times more sensitive to the violet than to yellow-green light (*12*). The contrast of the red gratings was calculated by weighting the light with the mean spectral field sensitivity function of Π_5 based on Stiles's four observers (*12*). Bleaching of photopigments in "red" receptors, caused by our intense lights partially changes spectral sensitivity of these receptors [G. S. Brindley, *J. Physiol. (London)* **122**, 332 (1953)]. Thus, the calculated contrast of the red gratings for Π_5 is only an approximate estimation, and this is why we also specify the radiance of the red gratings.
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Affective Discrimination of Stimuli That Cannot Be Recognized

Abstract. *Animal and human subjects readily develop strong preferences for objects that have become familiar through repeated exposures. Experimental evidence is presented that these preferences can develop even when the exposures are so degraded that recognition is precluded.*

A substantial body of evidence demonstrates that the mere repeated exposure of a stimulus object increases its attractiveness (*1*). Both human (*2*) and animal subjects (*3*) exhibit the exposure effect with a variety of stimuli, exposure methods, and outcome measures of stimulus attractiveness.

In addition to its effects on preferences, exposure experience also allows the individual to learn a great deal about the stimulus object, so that the ability to recognize, discriminate, and categorize the object generally improves. Traditionally, theorists have assumed that this cognitive mastery resulting from experience with the stimulus mediated the growth of positive affect [for example, Harrison's response competition theory (*4*) and Berlyne's theory of optimal arousal (*5*)]. Thus, as the individual comes to "know" the stimulus better, his affective reaction to it is likely to become increasingly positive. For example, much of the literature on esthetic reactions to music suggests that experience leading to the recognition of familiar patterns and the ability to anticipate development is pleasurable and makes the composition attractive (*6*).

Recent research, however, suggests that overt affective responses may be unrelated to prior cognitive outcomes which result from stimulus exposure. For example, Moreland and Zajonc (*7*) have shown by a correlational analysis that repeated exposure increases preference for stimuli even when recognition is held constant, and Wilson (*8*) has demonstrated by experimental methods that auditory stimuli gain in attractiveness by virtue of repeated exposure, even when their registration and subsequent recognition had been considerably impaired in the course of a dichotic listening task.

In the present experiment, a more stringent test was used to determine whether the exposure effect could be obtained when recognition was drastically reduced. Through preliminary studies, the conditions of stimulus exposure were systematically impoverished until recognition performance was brought down just to a chance level. A new group of subjects was then exposed to stimuli under these impoverished conditions, and judgments of attractiveness and measures of recognition memory for these stimuli and for stimuli not previously exposed were obtained. The results revealed clear preferences for exposed stimuli, even though subjects in a recognition memory test could not discriminate them from novel stimuli.

The experiment consisted of an exposure phase and of a test series. The stimuli were 20 irregular octagons constructed by a random process. Octagons of this type were used previously in exposure research, and subjects found no difficulty in making clear cognitive and affective discriminations among them (*9*). The 20 stimuli were divided into two sets of ten, sets A and B. In the exposure phase, half of the subjects saw set A and half set B. All subjects saw sets A and B in the test series. During the exposure phase, subjects fixated the center of a 23 by 17 cm rear projection screen mounted at the end of a viewing tunnel 91 cm long. Five exposures of each stimulus from the set of ten stimuli were shown in a random sequence. The octagons were solid black on white background; because of their high contrast, chance recognition could be obtained only after exposures were reduced to a 1-msec duration and illumination was lowered by a neutral density (ND8X) and a red gelatin filter. The instructions to subjects at the beginning of the exposure phase were that the experiment consisted of two parts and that during the first part slides would be shown on the screen at durations so brief that one could not really see what was being presented. Nevertheless, the subject was instructed to pay close attention to the flashes, even if nothing could be distinguished, and to acknowledge verbally the occurrence of each flash.

The second part of the experiment required subjects to make paired comparisons between slides from set A and set B. Now the slides were presented under adequate viewing conditions (exposure time was extended to 1 second). For each of the ten pairs, all containing one octagon previously exposed and one new, the subjects had to indicate (i) the

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one they liked better and (ii) the one they thought had been shown previously. For both judgments, confidence ratings were obtained on a three-point scale: "sure" (3 points), "half-sure" (2 points), and "guess" (1 point). Two groups of 12 subjects were studied, one making affective judgments of the ten stimulus pairs first and recognition judgments of the same pairs afterward, and another for whom the order of these judgments was reversed.

Recognition performance was very close to chance (48 percent accuracy). Affect responses, however, did reliably discriminate between old and new stimuli: old stimuli were liked better than new ones 60 percent of the time ($\chi^2 = 8.44$, $P < .01$). Overall, 16 of the 24 subjects preferred old to new stimuli, but only 5 of the 24 recognized old stimuli as such at better than the chance level. Of the 24 subjects, 17 discriminated better between old and new stimuli in their affective judgments than in their recognition responses, while only 4 showed superiority of recognition memory over affective judgments.

Subjects' confidence ratings show an interesting pattern (Fig. 1). When they reported they were just guessing, recognition accuracy and affective discrimination were both at chance levels (47 and 48 percent, respectively). Recognition accuracy did not improve when subjects were either "half-sure" or "sure" of their recognition judgments (49 and 45 percent). In contrast, at these levels of confidence, affective discrimination was considerably more accurate (63 and 60 percent).

These effects are slightly more pronounced when the affective and recognition judgments were obtained first, and were therefore unbiased by prior responses to the test stimuli. Accuracy for affective judgments made prior to recognition judgments tended to be higher than the overall levels, while accuracy for recognition-first judgments tended to remain about the same.

Confidence in affective preferences was substantially higher than in recognition judgments. Mean confidence in affective discrimination was 2.29, while confidence in recognition judgments was 1.60 [$t(23) = 6.66$, $P < .01$] (*10*). The tendency for affective preferences to be rendered more rapidly than recognition judgments (2.76 and 2.97 seconds, respectively) was not significant.

Individuals can apparently develop preferences for objects in the absence of conscious recognition and with access to information so scanty that they cannot ascertain whether anything at all was

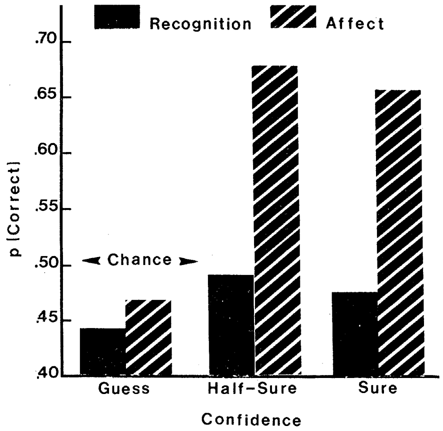

Fig. 1. Proportion of correct recognition and affective discriminations for first judgments in each category.

shown. The results thus suggest that there may exist a capacity for making affective discriminations without extensive participation of the cognitive system (*11*). In fact, evidence of this sort, together with data on the influence of affective judgments on recall and recognition (*12, 13*), has been taken to indicate that partially independent systems may encode and process affect and content (*12, 14*).

The fact that with minimal stimulus information, some forms of discrimination can be performed while others are not possible is not new. Studies of perceptual vigilance and defense have yielded findings obtained with modern methods and under conditions that satisfy the most stringent experimental criteria—findings that can no longer be seriously ignored (*15*). The large number of clear subliminal effects reported warrant the belief that various forms of affect-linked reactions are possible with only minimal access to the content. Shevrin (*16*), for example, found physiological and behavioral effects with 1-msec exposures. The recent work of Blum and Barbour (*17*), using hypnosis, confirms that affective reactions of various forms can take place with the content almost entirely suppressed.

Evidence for processing that occurs without an apparent access to the physical properties of verbal stimuli has been repeatedly reported. For example, subjects can identify a word sooner than they are able to identify its letters (*18*), and they can identify the semantic category of a word without being able to identify the word itself (*19*). Of course, what stimulus cues or internal processes allow the subject to make affective discriminations on the basis of what must surely be minimal processing of stimulus information cannot be established on the basis of what is now known. Perhaps from the point of view of survival value, however, it should not be entirely surprising that these affective discriminations can be made with so little stimulus information (*20*). Since affective reactions to a stimulus may readily change without any changes in the stimulus (as a result of repeated exposure, for example), these reactions must be based not only on the properties of the stimulus itself, but on information related to some internal states of the individual. Further empirical work may reveal the different bases of affective and cognitive judgments, should they indeed be partially separate and independent.

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20. There is no implication that one of these processes is more accessible to awareness. Either the affective or the cognitive process can become consciously available, depending on a variety of factors.
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