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CRITICAL FLICKER FREQUENCY UNDER MONOCULAR AND BINOCULAR CONDITIONS [1]

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Summary.—Critical flicker frequency of 40 undergraduate students, 20 men and 20 women whose mean age was 19.3 yr., was measured under monocular and binocular viewing conditions, using the Lafayette Visual Perception Control with Display Unit. Half of the subjects received monocular treatment first and binocular treatment second, and the other half received the treatments in the reversed order. A 2-min. rest was allowed between these treatments. Analysis shows that mean CFF under the monocular condition was significantly lower than that under binocular conditions. The findings were discussed in terms of visual constraint and eye strain and fatigue under the monocular viewing condition.

Critical flicker frequency (CFF), the rate at which successively presented stimuli appear to be fused and are perceived as steady and continuous, has been related to a number of psychophysiological variables (Caspari, 1951; Richards, 1981; McClelland, 1985) and personality (Frith, 1967; Waller & Lavender, 1980; Kirkcaldy, 1985; Ali, Jahan, & Choudhury, 1986). Recent studies have indicated that secondary school students showing antisocial behaviors have significantly lower CFF than a comparable group of normal students (Amir & Ali, 1989) and that food and water deprivation for a sufficient number of hours reduces CFF (Ali & Amir, 1989). The present study is, however, concerned with CFF as measured under monocular and binocular viewing conditions. There are monocular deprivation experiments in which one eye is blindfolded for a certain period of time, usually from 1 hr. to 24 hr. and then the effect of this deprivation on the CFF of either the nondeprived or the deprived eye is investigated. In one such long-term monocular-deprivation experiment, Loop and Frey (1982) found that CFF of the deprived eye was much lower than that of the nondeprived eye. There are also experimental studies which show the aftereffect of monocular deprivation on the CFF of nondeprived eye (Zubek & Harper, 1976; Zubek & Bross, 1972, 1973; Zubek, Bross, & Harper, 1976). Zubek & Harper (1976), for example, measured the CFF of nonoccluded eye before deprivation, at 3 and 6 hr. of monocular deprivation and again at 1, 3, 5, and 18 hr. following restoration of binocular vision of 10 male college students. Results showed depression of CFF at 6 hr. deprivation followed by a gradual return to the normal level 18 hr. after binocular vision was restored. Most of the above

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studies investigated the long-term effects of monocular deprivation on CFF. The shortest period of deprivation was 1 hr. A search of research literature yielded no study of the immediate effects of monocular and binocular vision on CFF. A study by Bowker and Mandler (1981), however, investigated the immediate effects of monocular and binocular observations of flickering light. Their method was different from that usually used in CFF experiments. In CFF experiments, the flicker frequency rate is increased to a point when the subject reports perceiving a steady light. In their experiment Bowker and Mandler did not change the rate of the flickering light. Instead, their subjects viewed the same flickering light monocularly as well as binocularly. Their finding was that the subject perceived the flickering light to be faster when viewed binocularly than when viewed monocularly. Thus, Bowker and Mandler did not investigate the immediate effects of monocular and binocular vision on CFF.

The present study was designed to measure critical flicker frequency under monocular and binocular conditions. Specifically, this study concerned the immediate effect of a monocularly and binocularly viewed flickering light on critical flicker frequency. In other words, to see whether the difference between monocular CFF and binocular CFF would be significant. Since higher CFF has been found to correlate positively with perceptual sharpening (Schwin, Hill, Goodwin, & Powell, 1974) and greater ability to discriminate visual stimuli (Kirkcaldy, 1985) and since the monocular viewing condition eliminates some visual cues, such as retinal disparity and convergence, it is hypothesized that monocular CFF would be significantly lower than binocular CFF.

METHOD

Forty undergraduate students, who were psychology majors (20 men and 20 women) and whose mean age was 19.3 yr. (SD = 1.5), participated in this experiment.

Critical flicker frequency was measured with a Lafayette Visual Perception Control with Display Unit which provides light stimulus of red color, with luminous intensity of 0.05 mw/cm^2 at a flash frequency from 2 to 60 cycles per second. Each subject was tested individually in both monocular and binocular conditions. The subject's left eye was blindfolded during the monocular condition. The apparatus and subjects' eyes were on the same line of vision and were 50 cm apart. Half of the subjects received monocular treatment first and binocular treatment second, and the other half received the treatments in the reversed order. A rest of 2 min. was allowed between the two treatments. The flickering stimulus was presented in an ascending and descending order, and in each condition, the stimulus was presented 10 times plus one practice trial. During the experiment all overhead lights were switched off except one 40-w lamp to maintain a constant background illumination. After the experiment, subjects were asked about the ocular comfort or strain they experienced during monocular and binocular viewing conditions.

RESULTS

The results of this experiment are summarized in Table 1. The table

shows the mean CFF of all subjects under monocular and binocular conditions. Entries show that CFF is significantly lower under the monocular condition than under the binocular condition. Data were also analyzed to see whether there were sex differences in CFF. Table 1 also shows that the mean CFF of men was significantly higher than that of women under both monocular and binocular conditions, although the means for CFF of both men and women were higher under binocular condition than those under monocular condition.

TABLE 1
MEANS, STANDARD DEVIATIONS, AND *t* RATIOS OF CRITICAL FLICKER FREQUENCY FOR MEN AND WOMEN UNDER MONOCULAR AND BINOCULAR CONDITIONS

Sex	*n*	Monocular CFF			Binocular CFF		
		M	*SD*	t_{19}	*M*	*SD*	t_{19}
Men	20	36.90	4.36		43.01	4.25	
Women	20	32.89	3.62	3.17*	38.94	2.43	3.71*
All	40	34.89	4.45		40.97	3.99	6.43*

*$p < .005$, one-tailed test.

DISCUSSION

The results which have been described before show that CFF under monocular viewing condition is significantly lower than CFF under binocular viewing condition ($p < .005$). This finding supports the hypothesis that monocular CFF is lower than binocular CFF. The finding of Bowker and Mandler (1981), mentioned earlier, that binocularly viewed flicker is faster than monocularly viewed flicker does not support or contradict our finding. What those authors observed was that a particular flicker rate appears faster when viewed binocularly than when viewed monocularly. Their finding, however, does not indicate whether flicker fusion will be delayed or augmented under the binocular viewing condition. Our finding clearly shows that the binocular flicker fusion rate is higher. In other words, flicker fusion is delayed under the binocular viewing condition, whereas it is augmented under the monocular condition. This finding is supported by the long-term monocular deprivation experiments mentioned earlier in which the CFF of the deprived eye was significantly lower than that of the nondeprived eye (Loop & Frey, 1982).

Why is monocular CFF shorter? It is perhaps shorter partly because the visual constraints imposed by the monocular viewing condition eliminate some visual cues, such as binocular disparity and convergence. We may also add that viewing an object monocularly for a long time may produce eye strain and fatigue as the subjects suggested in postexperimental interviews. The absence of certain visual cues plus the eye strain and fatigue might contribute to lower CFF under monocular condition. If higher CFF is an in-

dicator of increased perceptual sensitivity, as suggested by Schwin, *et al.* (1974) and Kirkcaldy (1985), our finding suggests that binocular vision gives superior vision.

The results in Table 1 further show that the mean CFF of men is higher than that of women. This sex difference contradicts the findings of a recent study by Amir and Ali (1989) who found that secondary schoolboys had lower CFF than girls. A previous study, however, indicated that men had a significantly higher mean CFF than women (Ginsburg, Jurenovskis, & Jamieson, 1982). The question of a sex difference in CFF, therefore, remains open to further investigation.

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