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NO SEX DIFFERENCES IN CONTRAST SENSITIVITY AND REACTION TIME TO SPATIAL FREQUENCY[1]

JENNIFER L. SOLBERG AND JAMES M. BROWN

University of Georgia

Summary.—This study investigated the possibility of sex differences in spatial frequency processing by measuring contrast sensitivity and reaction time to spatial frequency in the same 20 men and 20 women. This is the first study to investigate sex differences in reaction time to spatial frequency and the first to study sex differences in contrast sensitivity and reaction time within the same participants. No sex differences were found in either contrast sensitivity or reaction time measures, suggesting that women and men process spatial frequency information similarly.

In over 30 years of research into the response of the human visual system to spatial frequency information, few studies have addressed the issue of differences between men and women. Results of those studies of sex differences in the response to spatial frequency have been mixed. Whereas Brabyn and McGuinness (1979) found a sex difference in contrast sensitivity, several other researchers have not been successful in replicating this finding (Higgins, Jaffe, Caruso, & deMonasterio, 1983, 1988; Owsley, Sekuler, & Siemsen, 1983). Another measure that has been used to investigate the response to spatial frequency information is simple reaction time (Tolhurst, 1975). While many studies have reported sex differences in simple reaction time (Annett & Annett, 1979; Almirall & Guiterrez, 1987; Klinteberg, Levander, & Schalling, 1987), this is the first study to use spatial frequency-specific stimuli. In addition, this is the first study to measure the response to spatial frequency information using these two measures with the same participants.

Twenty male and 20 female undergraduates at the University of Georgia (aged 18 to 25 years) participated for course credit. Previous research has indicated sex differences in visual acuity (Burg & Hulbert, 1961; Burg, 1966); therefore, all participants were required to have uncorrected visual acuity of 20/30 or better as tested with an Orthorater. Contrast sensitivity and simple reaction time were measured for each participant using the same spatial frequencies (0.5, 1.5, 3.0, 6.0, and 12 c/deg.) with the order of measures counterbalanced across participants. These spatial frequencies were chosen to reflect the range used in previous studies of sex differences in contrast sensitivity (e.g., Brabyn & McGuinness, 1979; Higgins, *et al.*, 1983, 1988). The stimuli were Gabor patches subtending 4° and were presented on a Power-

[1]Please address correspondence to James M. Brown, Department of Psychology, University of Georgia, Athens, GA 30602-3013 or e-mail (jmbrown@arches.uga.edu).

Macintosh 6100/66 personal computer equipped with a 57-Hz Apple color monitor. While previous studies yielding no sex differences in contrast sensitivity used a forced-choice procedure and presented stimuli at a relatively high mean luminance, e.g., 128 cd/m^2 (Higgins, *et al.*, 1988), Brabyn and McGuinness (1979) used a method of limits and a mean luminance of 20 cd/m^2. We used a forced-choice procedure because of its greater sensitivity and reliability (Higgins, *et al.*, 1988) but chose a mean luminance of 35 cd/m^2 to be more similar to that in the study by Brabyn and McGuinness. Contrast sensitivity was measured using a two-interval, forced-choice staircase procedure (Morphonome™, 1997). Each 250-msec. interval was signaled by a tone separated by an interstimulus interval of 300 msec. Thresholds were measured five times for each of the five spatial frequencies tested. Simple reaction time to each spatial frequency was measured using the Superlab™ software package. Participants initiated each trial with a key press. A trial consisted of a variable blank interval (100, 200, 300, or 400 msec.) followed by the random presentation of one of the five Gabor stimuli. Participants responded to each stimulus with a key press. Each spatial frequency was presented 40 times.

Contrast sensitivity and reaction times are shown in Table 1. The data were analyzed in separate 2 × 5 (sex × spatial frequency) analyses of variance. Typical contrast sensitivity functions were found as evidenced by the significant main effect of spatial frequency ($F_{4,152} = 88.94$, $p < .05$) with no differences between men and women ($F_{1,38} = .745$, $p > .05$). These results are consistent with those of Higgins, *et al.* (1983, 1988) who also used a forced-choice procedure, and stimuli with a lower mean luminance. Thus, the difference between the results of Brabyn and McGuinness (1979) and Higgins, *et al.* (1988) is most likely not due to differences in the mean luminance of the stimuli in the two studies. The reaction time data also showed a significant main effect of spatial frequency ($F_{4,152} = 88.94$, $p < .05$), replicating the typical function wherein reaction time increases with increasing spatial frequency (e.g., Breitmeyer, 1975). Again, the main effect of sex was not significant ($F_{1,38} = 1.87$, $p > .05$).

TABLE 1
CONTRAST SENSITIVITY AND REACTION TIME TO SPATIAL FREQUENCY FOR MEN AND WOMEN ($ns = 20$)

Spatial Frequency	Contrast Sensitivity				Reaction Time (msec.)			
	Men		Women		Men		Women	
(cycles/deg.)	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
0.1	147.75	62.43	132.97	55.63	330.19	50.66	311.29	30.14
1.5	118.07	35.09	110.74	19.91	324.56	53.65	306.06	32.38
3.0	100.92	31.78	97.93	18.34	325.94	47.97	313.29	27.07
6.0	86.86	39.83	78.68	26.08	342.84	50.02	323.83	30.34
12.0	32.16	19.04	29.79	15.79	374.54	55.14	354.90	36.74

Our results suggest that men and women do not differ in terms of contrast sensitivity or reaction time to the spatial frequencies tested. The previous literature has been mixed on whether there are sex differences on these two measures. If women and men differed in terms of spatial frequency processing, sex differences should have been found on both contrast sensitivity and reaction time measures. However, no such differences were found. Present results are particularly compelling because both contrast sensitivity and reaction time to spatial frequencies were measured within the same sample. In addition to clarifying this issue in the literature, the results also have implications for past and further research using spatial frequency-specific stimuli. More generally these results suggest that, when sex differences in reaction time measures are found, they are not based on sex differences in sensitivity to the spatial frequency content of the stimuli.

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