LEVEL II

NIGHT VISION PERFORMANCE IN DETECTION AND IDENTIFICATION OF MOVING TARGETS AFTER GLARE

Final Report

July 1979

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The results indicate that performance on the glare recovery task cannot be predicted on the basis of contrast threshold alone. The results also show that one can predict glare recovery for either detection or resolution of different size targets, moving at different velocities on the basis of a single glare recovery measurement for a specific size and velocity using either detection or resolution as the criterion.

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FOREWORD

This Final Report was written for the U.S. Army Medical Research and Development Command by the investigators of a study supported by a U.S. Army Contract ((No. DAMD 17-77-C-7055). This contract was awarded to the Visual Sciences Division of Optical Sciences Group, Inc., San Rafael, California, which directed, guided, and administered the research study. The experimental phases of the study were conducted at the Smith-Kettlewell Institute of Visual Sciences at the Pacific Medical Center in San Francisco. We gratefully acknowledge the space, facilities, and services provided by the Institute.

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For the protection of human subjects the investigators have adhered to policies of applicable Federal Law 45CFR46.

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TABLE OF CONTENTS

	Page
Introduction	1
General Methods	2
Results and Discussion	4
Conclusions	8
Figures	10
Tables	15
References	17
Appendix A: Summary of Results for a Separate Experiment Involving Detection	18
Appendix B: Summary of Results for a Separate Experiment Involving Resolution	20

INTRODUCTION

Vision and vision performance are generally tested under conditions that are not easily related to the real life situation. For example, ability to resolve is measured using high contrast static targets presented at the fovea under high levels of background illumination while resolution in real life involves targets of all contrast levels, both static and moving, not necessarily presented to the fovea.

Relating the results of testing at nigh light levels to performance in the dark has proven to be difficult. The sizable individual differences that exist at photopic levels become exaggerated as sensitivity increases and resolution decreases with lower background levels. Kinney (1968), summarizing the reports of Ogilvie, et al (1955), Pirenne, et al (1957), and Uhlaner, et al (1953) states that "the almost universal finding has been that there is essentially no correlation between photopic and scotopic vision and that the correlation increases in size as the light levels used in testing are brought closer together."

The standard tests done under dark conditions measure detection for static targets, usually a spot, with the background light level held constant -- conditions which are not relevant to real life. In the practical situation, an individual may be required to both detect and resolve targets of various sizes. The targets may be static or moving at different velocities and may appear anywhere in the visual field. In addition, the environmental light level may be changing from scotopic to mesopic and even photopic for short periods of time as the individual may be exposed to glare.

As night operations in a military context continue to be of interest, it becomes important to describe vision performance for these complex and relevant tasks and tc understand how the performance changes as the parameters of task criterion, target velocity, target size, and adaptation level change.

For practical reasons it is impossible to perform all relevant tests on all people who will be exposed to low light levels as part of their job in the military situation. For these reasons, it would be helpful to determine the minimal set of measures needed to predict performance outside the laboratory. The purpose of these experiments was to describe vision performance at low light levels for conditions that more closely approximate real life and to determine what minimally needs to be measured in an individual to predict performance in a more general sense.

GENERAL METHODS

Twenty-five male volunteer subjects participated in these experiments; all had visual acuity of 20/20, corrected when necessary. Five subjects participated in the main experiment. The subjects were seated nine feet from a hemicylindrical screen with a radius of 9 feet and luminance $2.4 \times 10^{-3} cd/m^2$. All subjects were dark-adapted for 10 minutes prior to testing. Contrast thresholds without glare were initially measured. Contrast thresholds were determined monocularly using a staircase method. A high-contrast target was presented after a warning tone and the subject was instructed to push one button if it was visible and another if it was not. If the target was visible, the contrast was reduced by a fixed amount and the target was presented again. If the target was not seen, the contrast was increased a fixed amount. The mean of five reversals of contrast increment/decrement was taken as the threshold. Thresholds were measured with detection and resolution as the endpoint. In the experiment involving resolution, the subject had to correctly identify two consecutive target orientations before the contrast was changed. Each subject was tested on two separate days, one day for detection endpoints and the other for resolution. Three Landolt C target sizes were used; 10%, 35%, and 60% Snell-Sterling corresponding to Snellen acuities of 20/277, 20/137, and 20/77 respectively. The targets moved horizontally through an amplitude of 10^{o} with constant speed (triangular waveform). Three velocities were used: 5.4 deg/s, 9.0 deg/s, and 14.3 deg/s. Stationary targets were also employed.

After a short rest period, glare recovery was measured for the same target sizes and velocities used for the threshold determination. One eye was exposed to a glare source of luminance $1.2 \times 10^{4} cd/m^2$ which subtended 55^{o}; the exposure duration was 10 seconds. The subject's attention was then directed towards the screen where the test target was presented either stationary or moving. Two bold, black horizontal fixation markers indicated the path of the test target. When the subject recovered contrast sensitivity enough to either detect or resolve the target (depending on the experiment), he pushed a button. The button push caused a neutral density wedge under computer control to decrease the contrast of the target to another pre-determined level which was below threshold, and the subject was instructed to push the button again when the target became visible. Recovery times were measured in this fashion for five pre-determined target contrast levels.

The targets in all experiments were white Landolt C's of three different sizes projected onto the screen. The gaps of the C's were oriented obliquely; preliminary experiments had demonstrated that obliquely oriented C's were equally visible at each possible orientation. In the experiment using resolution of the target as the endpoint, the subject had to correctly identify two consecutive target orientations before the contrast of the target was reduced to the next lower level. Each time the subject pushed a button, the target orientation was changed. The contrast level for each target size was the same for all target velocities including static targets. The target contrast was changed, however, as target size changed such that the larger the target, the lower the contrast. The contrast levels ranged from approximately 1.5 log units above threshold for the first and brightest target to about 0.5 log unit above threshold for the fifth and dimmest target. The contrast levels were changed slightly from subject to subject. This procedure was necessary to make sure that all subjects saw all sizes of targets moving at all speeds. The order of presentation of the various sizes and velocities was randomized in all experiments. The subjects were given 20-30 minutes of practice performing the tasks prior to data collection.

RESULTS AND DISCUSSION

1. RESOLUTION AND DETECTION CONTRAST THRESHOLDS AS A FUNCTION OF TARGET VELOCITY AND TARGET SIZE.

There is a linear relation between target size and contrast threshold for resolution and detection. The difference between resolution and detection thresholds is constant. Fig. 1 shows the thresholds for detection and resolution collapsed across target velocity for 3 target sizes. Both functions are reasonably linear and the separation between detection and resolution remains constant for all sizes (0.6 log units). The fact that there is a linear relationship between threshold and target size and a constant relationship between detection and resolution allows prediction of performance for different target sizes and for either task based on the measurement of only one point. For example, it is possible to measure detection threshold for an intermediate target size in a given subject and use the data in Fig. 1 to predict the contrast levels required for this person to detect and resolve targets of different sizes. The results indicate that changing the size by a factor of 2 would require a change of approximately 0.45 log units in contrast for the new target to be detected at this dim background level.

The sensitivity for detection is lowest for static targets, increases for moving targets up to some velocity which is target size dependent and then decreases again. Sensitivity for resolution, however, generally is best for static targets and decreases progressively as target velocity is increased. These results are shown graphically in Fig. 2 which depicts detection and resolution thresholds collapsed across target size as a function of target velocity. The data shown in Table 1 show the results for detection resolution prior to collapsing across velocity.

Moving targets are always detected more easily than static targets over the range of velocities used in this experiment. These results have been confirmed in a separate experiment on 8 subjects using the same target parameters. (See results in Appendix A.) The faster the target moves, the greater the difference between the retinal location of the target and the fovea. Aulhorn and Harms (1972) have shown that detection sensitivity at these light levels improves out to at least ten degrees; if the error between eye and target increases, sensitivity is expected to increase. Some factor other than eye movement error must also be involved since the sensitivity increases as velocity increases up to a point but then decreases again. A possible explanation is that the targets move so fast that the critical area-duration relationship at any one retinal locus is not fulfilled and more light is required for detection.

The sensitivity for resolution is best for static targets and becomes progressively worse as target velocity increases. The threshold rise is non-linear, accelerating at faster velocities. This may be due to decreased eye movement accuracy for rapidly moving targets. The underlying assumption in this case is that sensitivity for resolution is highest in the fovea and decreases with retinal eccentricity. Our preliminary experiments determining static resolution thresholds for the fovea and retinal eccentricity up to 10° indicates that this is true. These results reported in our preliminary annual report for this contract are contrary, however, to previous reports by others who claim that at scotopic light levels, peripheral retinal locations have the best resolution capability (Mandelbaum and Sloan, 1947; Low, 1946; Shlaer, 1937). This point obviously deserves further study.

Another interesting aspect of the results for detection is not apparent in Fig. 2 because the data was collapsed across target size. Detection sensitivity improves with velocity up to a certain velocity and then decreases as mentioned previously. This "optimal velocity" appears to shift to lower velocities as target size becomes smaller. The extrapolated "optimal velocity" for different target sizes is shown in Fig. 3. The "optimal velocity" was extrapolated from the detection threshold data for the 8 subjects (shown in Appendix A) and from the 5 subjects in this experiment. For both groups there is a linear relationship between target size and optimal velocity -- the smaller the target, the slower the velocity with best sensitivity, i.e., optimal velocity. The absolute values of optimal velocity vary slightly for the two groups, and probably only reflect the difficulty extrapolating the optimal velocity from each set of data. The significance of this linear relationship is unclear.

Is it correct to assume that if an individual has low thresholds for detection, will he also have low thresholds for resolution? The results of correlation between each subject's detection thresholds and his resolution thresholds indicate that it is generally true that the better you are at detecting, the better you will be at resolving targets -- the correlation coefficient is 0.78.

2. GLARE RECOVERY FOR RESOLUTION AND DETECTION AS A FUNCTION OF TARGET VELOCITY AND TARGET SIZE.

Glare recovery time as a function of log target contrast was generated for each subject for a variety of target sizes and velocities. These functions were non-linear. To facilitate comparison between target parameters the recovery time data were converted to log time. For each of the target conditions, the data for all the subjects were pooled and linear regression analysis performed. The approximations to straight lines were satisfactory - the correlation coefficients vary from 0.49 to 0.92. The parameters of the calculated regression lines for all target configurations for detection and resolution criteria are shown in Table 2. The correlation coefficients between log target contrast and log recovery time are generally higher for the resolution than the detection tasks indicating less intra-subject variability for resolution. The lower slopes for detection are another indicator that there is more variability in the detection data.

Glare recovery time is linearly related to target contrast for the narrow range of contrasts used in these experiments; this is true for both resolution and detection. Figure 4 shows the regression lines for log glare recovery time collapsed across velocities as a function of log target contrast. For both resolution and detection the slopes for the three different target sizes are not significantly different from each other -- the ordinate intercepts are (Analysis of co-variance). Considerably more light is required to resolve the targets than to detect them. Target contrast must be increased approximately by a factor of 4 (0.60 log units) for a target to be resolved at the same time after glare. This contrast difference between detection and resolution to produce the same glare recovery time is approximately the same for all three target sizes. Another way to look at these results is to ask the question: how much time must elapse before a detected target can be resolved. The functions in Fig. 4 indicate that it requires approximately twice as long to resolve a target of specific contrast than to detect it.

Glare recovery times for detection are always shorter for stationary targets. At all other velocities the glare recovery times are longer and appear to be relatively independent of velocity. There is no optimal velocity effect as was seen prior to glare exposure. The effect of target velocity on glare recovery time for detection and resolution is illustrated in Figure 5, which shows the regression lines for the glare recovery data collapsed across target sizes. The results for each velocity were compared using analysis of covariance.

No significant differences in slope or intercept were found for the detection data for moving targets. The analysis showed, however, that significantly shorter times are needed to detect the static targets compared to the fast moving ones ($p < .025$); that is, the ordinate intercepts are statistically different. Similar results were obtained in a separate experiment summarized in Appendix A. This result is interesting in view of the fact that the detection thresholds without glare showed that moving targets are seen more easily than static ones. It may be that detection thresholds for moving targets are only lower than static ones for adaptation levels that are very low, when the parafoveal area is more sensitive than the foveal area. Exposure to glare obviously alters the state of adaptation. If the glare exposure acts to raise the effective level of retinal adaptation in a similar manner to that described by the equivalent light concept (Barlow, 1964), then for some time after glare the fovea can be expected to have the highest retinal sensitivity. When the foveal sensitivity is greater than surrounding retinal sensitivity the threshold should be lower for stationary foveally fixated targets.

The results in Figure 5 show that there is no velocity effect for resolution. This result was confirmed in a separate experiment on 6 subjects described in Appendix B. In fact, there is no significant difference in either slope or ordinate intercept for the resolution data. The lack of velocity effect for the constant velocity targets was a surprise, since our previous work (Brown, 1972; Adams et al, 1976) revealed significant velocity effects for resolution of ramp targets without glare. Brown (1972) has shown that the velocity effect on resolution, which results in worse resolution for faster targets, is mainly caused by the oculomotor system when exposure duration is limited. The subject simply does not have enough time to move his eyes in such a way that the target is presented at or near the fovea. At photopic levels, the further off the fovea the target image is located, the worse the resolution capability. Our previous experiments with ramp targets, which demonstrated a velocity effect, limited target exposure to 500 msec, while the exposure duration was unlimited in the present experiment. In this case, there is time to locate the target on or near the fovea. There is thus no difference in resolution capability whether the target moves at 5 or 14 deg/sec. We anticipate, however, that glare recovery will be dependent on target velocity if the exposure time is short.

CONCLUSIONS

How well can the contrast threshold data be related to glare recovery data for resolution and detection? If a person has high contrast thresholds it would be expected that his glare recovery time to a target at some preset contrast level would be longer than the recovery time for another person who has low contrast thresholds -- their baseline capabilities are different. To minimize baseline differences and isolate the dynamic function of recovery, we adjusted for differences in contrast threshold by subtracting the contrast threshold from the preset glare recovery target contrast levels and calculated regression lines for recovery time as a function of adjusted contrast. Previous experience using this procedure at photopic levels had demonstrated that adjustment of contrast levels decreases variability of the group data and improves the correlation between contrast and glare recovery time. In this case, however, there was no improvement in the correlation coefficients -- in fact, the coefficients for several of the target configurations decreased. These results indicate that at scotopic background levels there is very little correlation between contrast thresholds and glare recovery time. It is thus possible for a person to detect targets at very low contrast levels without glare and require considerably higher contrast levels after glare than another who has very poor contrast thresholds without glare. In other words, one cannot predict performance on the glare recovery task on the basis of contrast thresholds alone.

What is required as a minimal set of measurements to predict visual performance where detection and resolution must be achieved in the complex situation of various target sizes moving at a variety of velocities following exposure to glare? First, it can be seen from the data in Fig. 5 that there is essentially no velocity dependent function for glare recovery -- a considerable simplification. Second, there is a linear relationship between target contrast and glare recovery time over the range of contrasts used in these experiments. This function has the same slope for all target sizes and requires only a fixed contrast step to adjust for the relative visibility of different sized targets. Further, detection and resolution recovery times bear a constant relationship to each other. In our glare experiments is always takes twice as long to resolve any given target than to detect it. To get the same recovery times for detection and resolution at a given target size, the target must have 4 times the contrast for resolution.

Because of the above relationships, illustrated in Figures 4 and 5, one can predict glare recovery for either detection or resolution of targets of different sizes, moving at different velocities on the basis of a single glare recovery measurement for a specific size and velocity using either detection or resolution of the target as the endpoint.

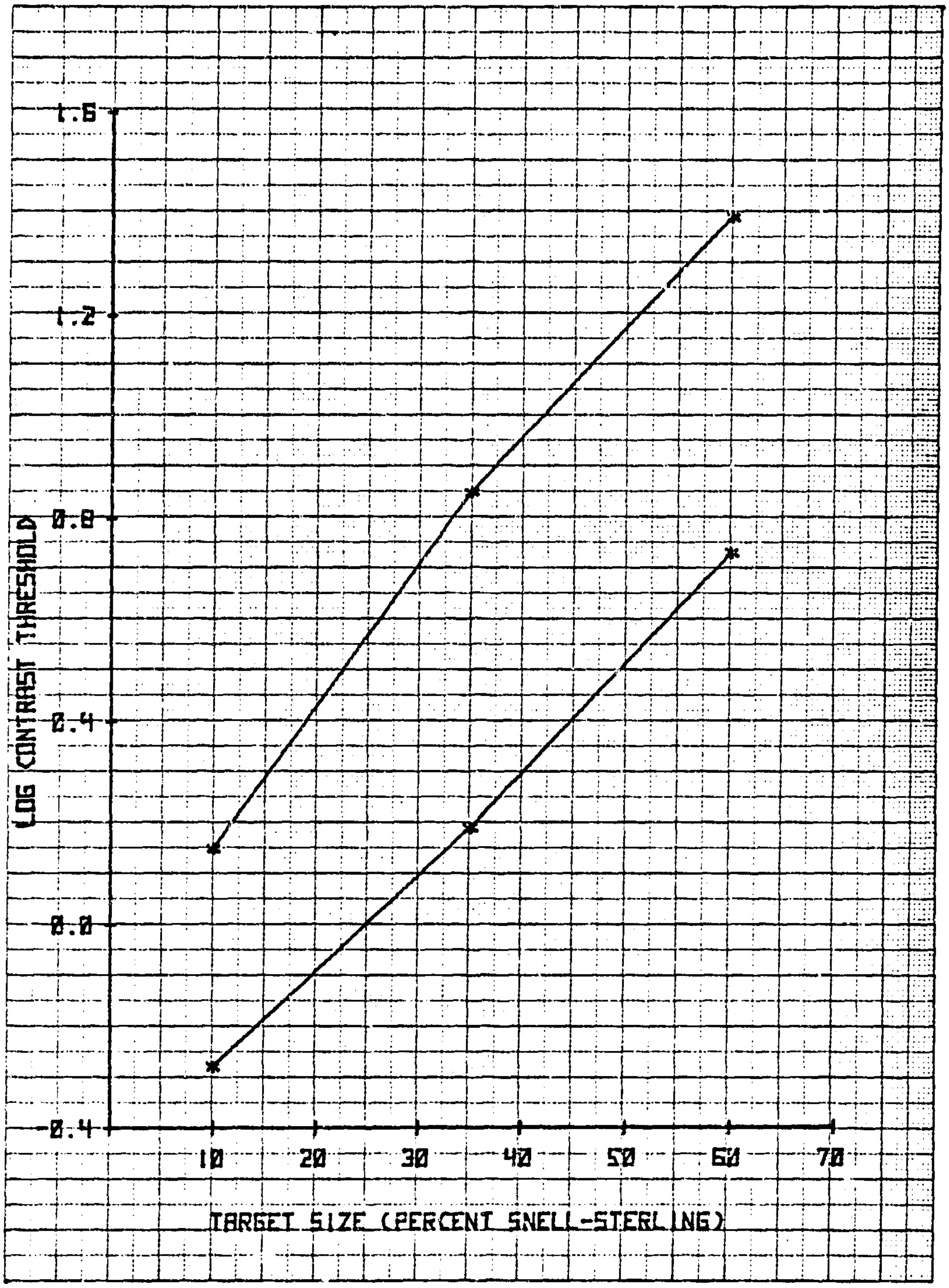

FIGURE 1. Log contrast thresholds collapsed across target velocities are shown for three target sizes (10%, 35%, and 60% Snell-Sterling, corresponding to Snellen 20/277, 20/137, and 20/77) for detection (lower set of data) and resolution (upper set of data). These contrast thresholds without glare were measured for Landolt C targets against a dim background $(2.4 \times 10^{-3} cd/m^2)$ in a group of 5 subjects.

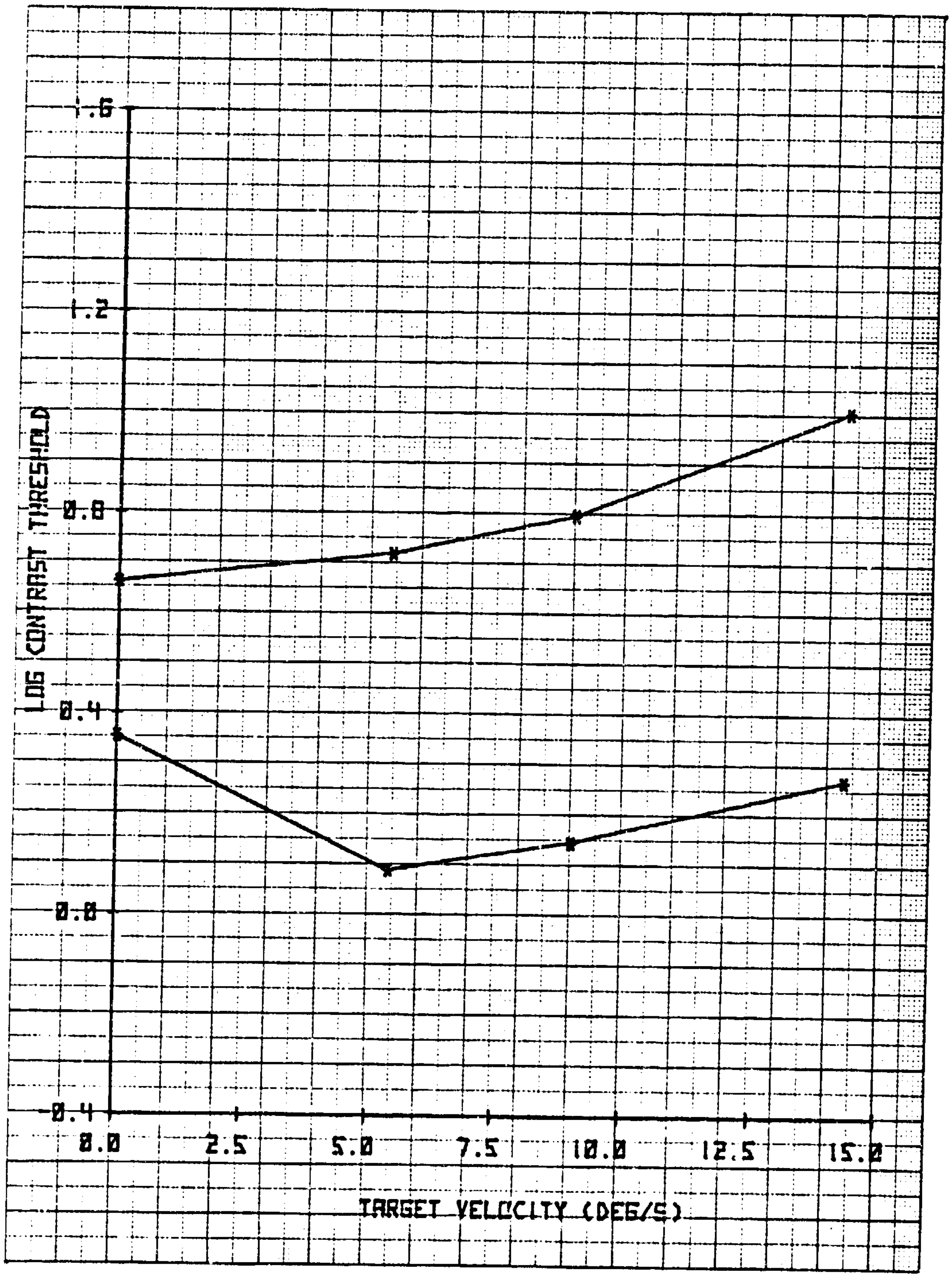

FIGURE 2. Log contrast thresholds collapsed across target size are shown as a function of target velocity for detection (lower set of data) and resolution (upper set of data). These contrast thresholds without glare were measured against a dim background $(2.4 \times 10^{-3} cd/m^2)$ in a group of 5 subjects.

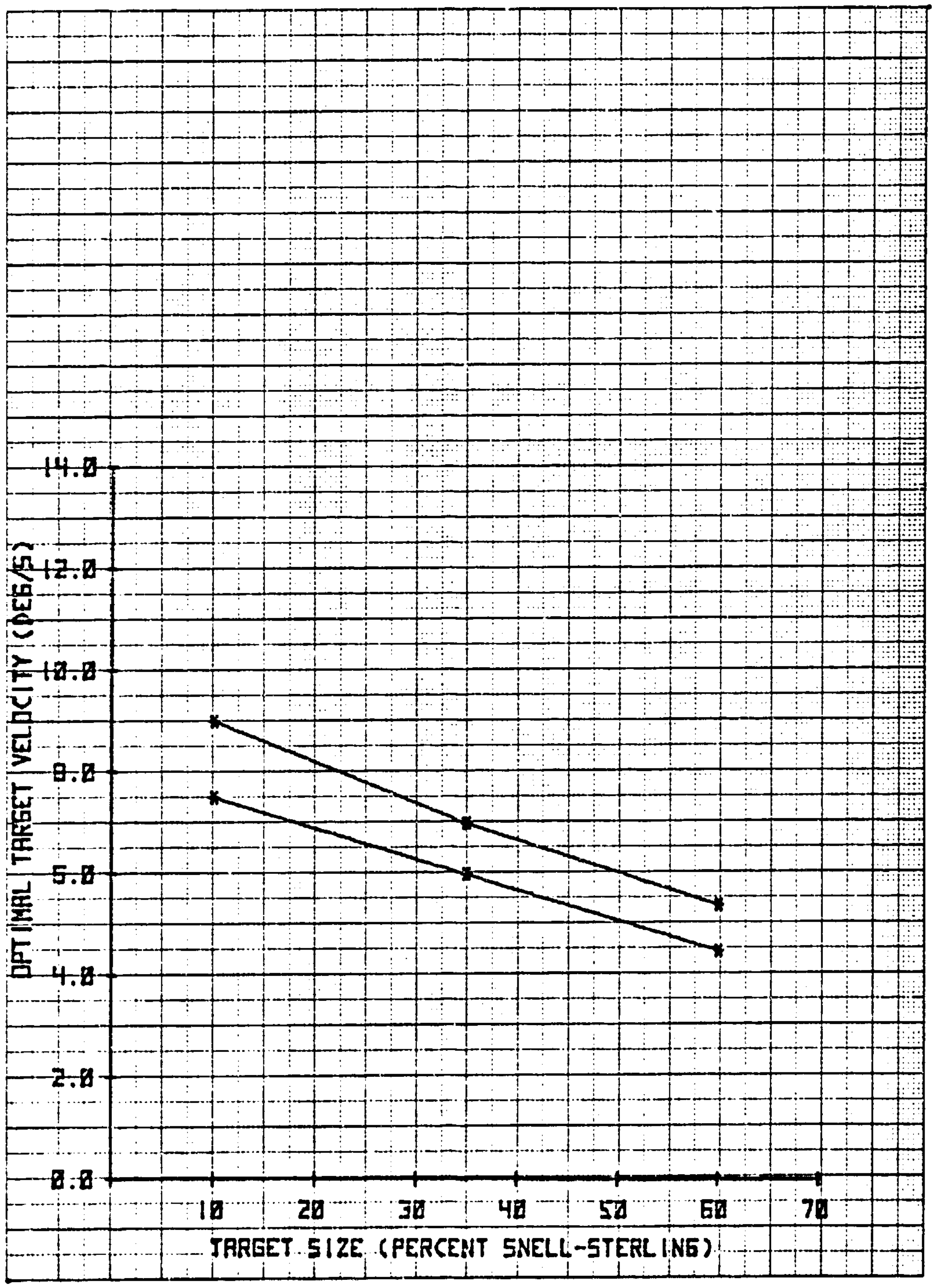

FIGURE 3. The target velocity that produced the lowest detection threshold in the dark is shown for three target sizes. The "optimal" target velocity was extrapolated from the results of two separate experiments, one involving 8 subjects (upper set of data) and another involving 5 subjects (lower set of data).

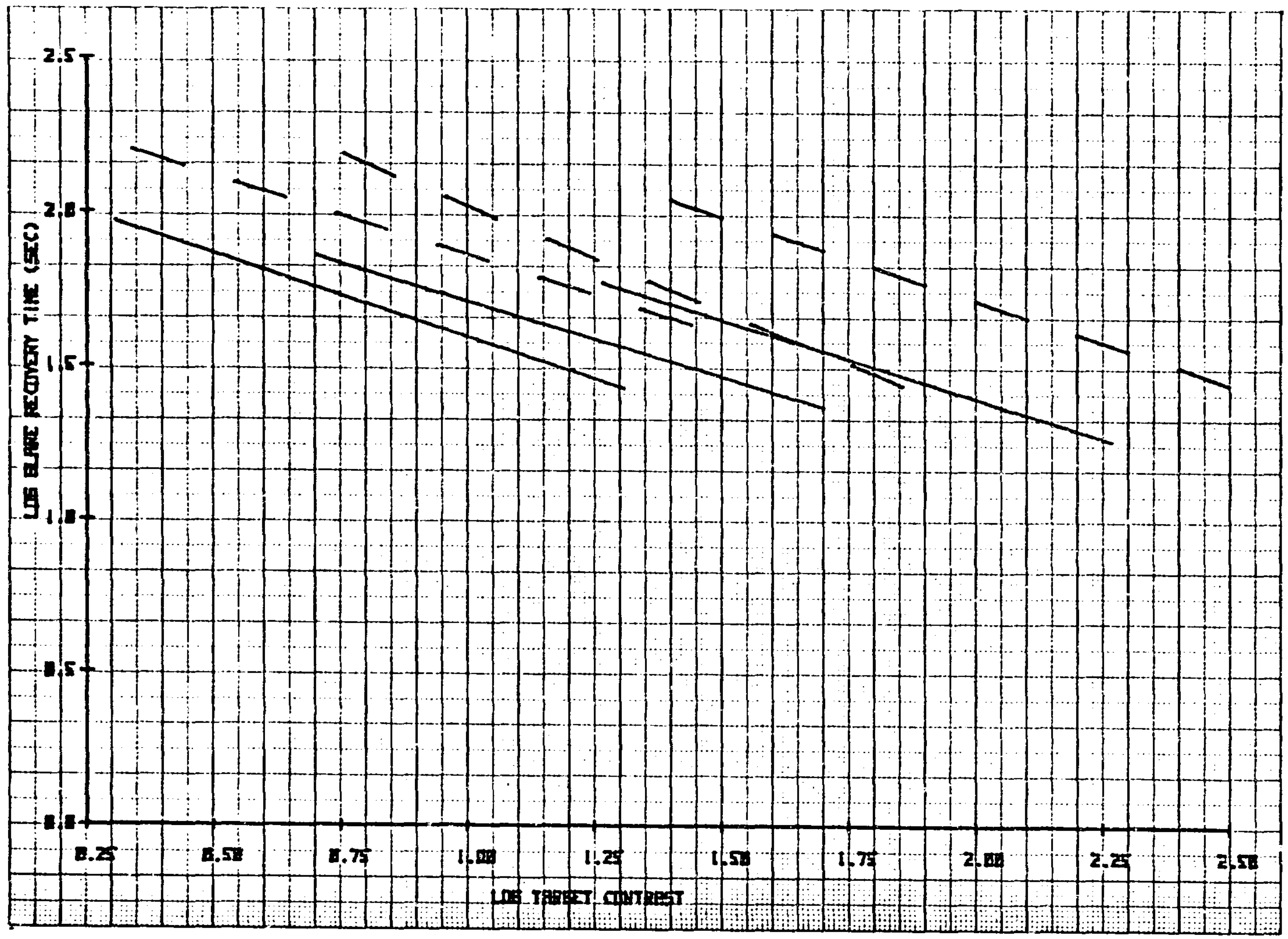

FIGURE 4. Regression lines for log glare recovery time collapsed across target velocity versus log target contrast are shown for three target sizes (from left to right): 10% Snell-Sterling corresponding to Snellen 20/277; 35% (20/137), and 60% (20/77). The solid lines represent the results for detection endpoints while broken lines show the results for resolution. The Landolt C targets were presented against a dim background ($2.4 \times 10^{-3} cd/m^2$). The 5 subjects were dark-adapted prior to glare exposure.

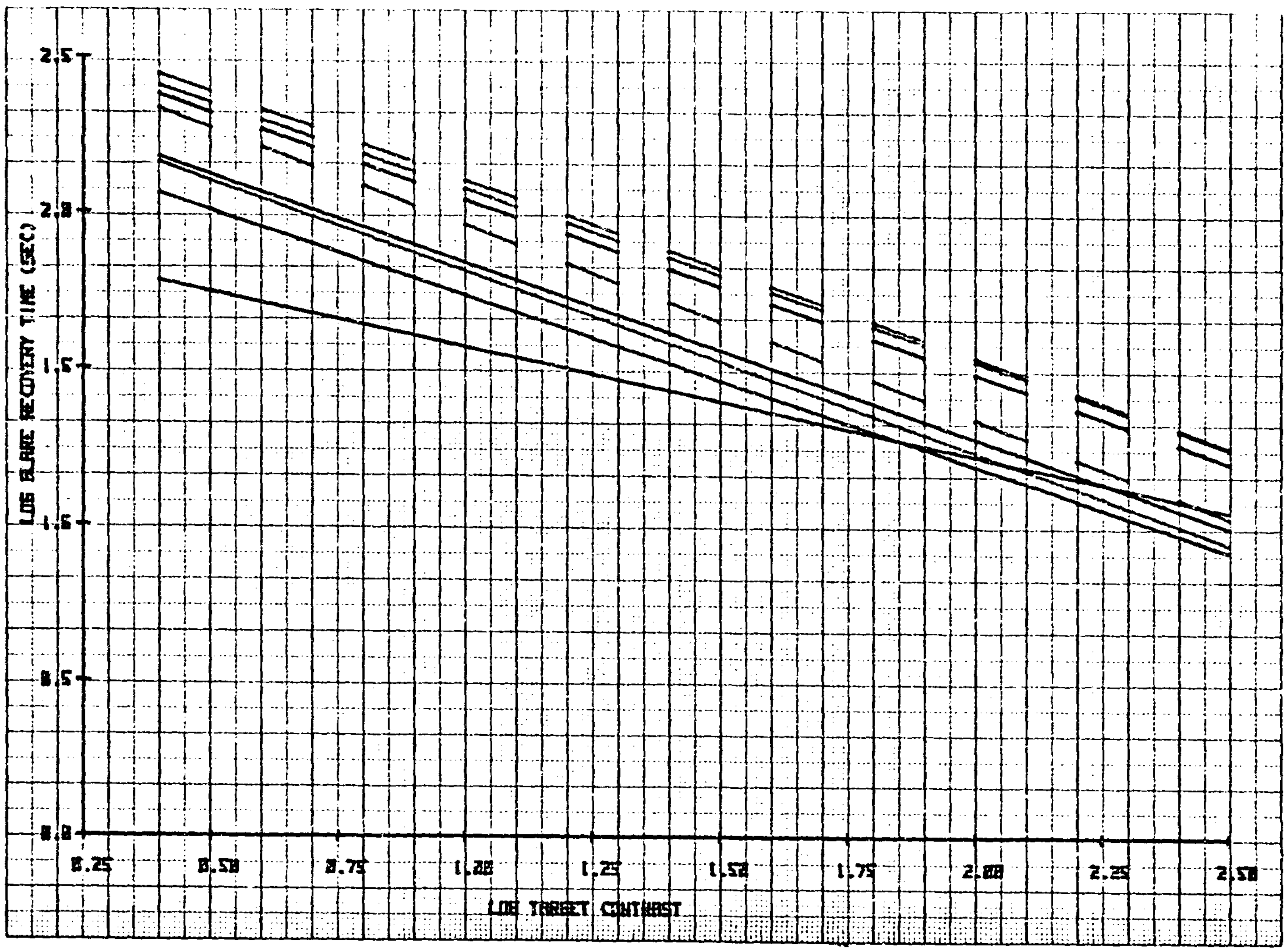

FIGURE 5. Regression lines for log glare recovery time collapsed across target size versus log target contrast are shown for four target velocities. The solid lines represent results for detection (atthe left of the figure, from bottom to top): 0 deg/s, 5.4 deg/s, 9.0 deg/s, and 14.3 deg/s. The broken lines show the results for resolution (at the left of the figure from bottom to top: 0 deg/s, 5.4 deg/s, 9.0 deg/s, and 14.3 deg/s. The glare recovery measurements were performed in the dark in a group of 5 subjects who were dark-adapted prior to glare exposure.

Size (% Snell-Sterling)	Velocity (deg/s)	Detection Mean	Detection S.D.	Resolution Mean	Resolution S.D.
10	0	-0.16	0.39	-0.12	0.45
	5.4	-0.38	0.21	0.11	0.20
	9.0	-0.36	0.15	0.10	0.16
	14.3	-0.22	0.16	0.52	0.58
35	0	0.42	0.32	0.84	0.08
	5.4	0.05	0.13	0.72	0.16
	9.0	0.09	0.22	0.83	0.13
	14.3	0.22	0.18	1.00	0.24
60	0	0.80	0.27	1.27	0.24
	5.4	0.61	0.23	1.33	0.14
	9.0	0.71	0.15	1.46	0.16
	14.3	0.81	0.14	1.50	0.06

TABLE 1. Contrast thresholds for detection and resolution criteria without glare in the dark for static and moving targets in the same group of five subjects.

Size (% Snell-Sterling)	Velocity (deg/s)	Log Contrast (mean)	Log Time (mean)	Slope	Ordinate Intercept	Correlation Coefficient
DETECTION						
10	0	0.81	1.58	-0.35	1.87	-0.52
	5.4	0.81	1.64	-0.60	2.12	-0.59
	9.0	0.81	1.80	-0.63	2.31	-0.60
	14.3	0.81	1.77	-0.57	2.23	-0.69
35	0	1.20	1.53	-0.28	1.87	-0.32
	5.4	1.20	1.60	-0.65	2.38	-0.74
	9.0	1.20	1.63	-0.47	2.20	-0.54
	14.3	1.20	1.69	-0.59	2.36	-0.66
60	0	1.77	1.32	-0.44	2.11	-0.64
	5.4	1.77	1.54	-0.44	2.32	-0.58
	9.0	1.77	1.56	-0.62	2.66	-0.66
	14.3	1.77	1.64	-0.53	2.58	-0.60
RESOLUTION						
10	0	0.94	1.85	-0.56	2.38	-0.76
	5.4	0.94	1.88	-0.47	2.32	-0.44
	9.0	0.94	1.90	-0.54	2.41	-0.70
	14.3	0.94	1.93	-0.48	2.38	-0.49
35	0	1.36	1.70	-0.75	2.71	-0.92
	5.4	1.36	1.83	-0.68	2.75	-0.86
	9.0	1.36	1.76	-0.59	2.56	-0.68
	14.3	1.36	1.83	-0.70	2.77	-0.81
60	0	2.00	1.53	-0.56	2.65	-0.89
	5.4	2.00	1.78	-0.53	2.83	-0.67
	9.0	2.00	1.74	-0.55	2.85	-0.65
	14.3	2.00	1.82	-0.52	2.86	-0.54

TABLE 2. Parameters of regression lines for log glare recovery time (sec) as a function of log contrast with detection and resolution as endpoint criteria in the same group of five subjects. The targets moved with constant velocity.

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APPENDIX A

Summary of Results for a Separate Experiment Involving Detection

Size (% Snell-Sterling)	Mean Velocity (deg/s)	Sinusoidal Motion Mean	Sinusoidal Motion S.D.	Size (% Snell-Sterling)	Mean Velocity (deg/s)	Triangular Motion Mean	Triangular Motion S.D.
10	0	0.11	0.45	10	0	-0.12	0.31
	4.1	-0.25	0.11		5.4	-0.25	0.33
	6.4	-0.26	0.13		9.0	-0.30	0.16
	10.1	-0.16	0.14		14.3	-0.17	0.16
35	0	0.44	0.40	35	0	0.46	0.27
	4.1	0.06	0.17		5.4	0.10	0.19
	6.4	0.16	0.14		9.0	0.12	0.19
	10.1	0.20	0.12		14.3	0.25	0.17
60	0	0.74	0.32	60	0	0.81	0.22
	4.1	0.49	0.24		5.4	0.63	0.19
	6.4	0.56	0.21		9.0	0.71	0.12
	10.1	0.63	0.18		14.3	0.84	0.12

APPENDIX A, TABLE 1. Detection thresholds without glare in the dark for static and moving targets in two groups of 8 subjects each. Target motion was sinusoidal for one group and triangular for the other. The methods of data collection were identical to those described in the main test.

Size (% Snell-Sterling)	Velocity (deg/s)	No. of Subj.	Log Contrast (mean)	Log Time (mean)	Slope	Ordinate Intercept	Correlation Coefficient
SINE		8					
10	0		0.82	1.56	-0.57	2.02	-0.79
	4.1		0.82	1.57	-0.45	1.94	-0.50
	6.4		0.82	1.54	-0.43	1.89	-0.47
	10.1		0.82	1.63	-0.63	2.14	-0.69
35	0		1.13	1.53	-0.50	2.10	-0.58
	4.1		1.13	1.55	-0.36	1.96	-0.41
	6.4		1.13	1.53	-0.50	2.10	-0.58
	10.1		1.13	1.64	-0.55	2.27	-0.56
60	0		1.64	1.44	-0.45	2.17	-0.69
	4.1		1.64	1.38	-0.53	2.24	-0.71
	6.4		1.64	1.45	-0.53	2.32	-0.61
	10.1		1.64	1.56	-0.63	2.59	-0.68
TRIANGLE		8					
10	0		0.82	1.59	-0.43	1.94	-0.65
	5.4		0.82	1.68	-0.66	2.23	-0.61
	9.0		0.82	1.78	-0.69	2.35	-0.60
	14.3		0.82	1.75	-0.72	2.34	-0.72
35	0		1.21	1.47	-0.53	2.11	-0.56
	5.4		1.21	1.55	-0.74	2.44	-0.76
	9.0		1.21	1.60	-0.67	2.41	-0.71
	14.3		1.21	1.67	-0.73	2.55	-0.75
60	0		1.78	1.36	-0.51	2.26	-0.68
	5.4		1.78	1.50	-0.57	2.52	-0.73
	9.0		1.78	1.56	-0.59	2.61	-0.73
	14.3		1.78	1.61	-0.70	2.86	-0.75

APPENDIX A, TABLE 2. Parameters of regression lines for log glare recovery time (sec) as a function of log contrast with detection as the endpoint criterion for two groups of 8 subjects each.

APPENDIX B

Summary of Results for a Separate Experiment Involving Resolution

Size (% Snell-Sterling)	Velocity (deg/s)	No. of Subj.	Log Contrast (mean)	Log Time (mean)	Slope	Ordinate Intercept	Correlation Coefficient
SINE		9					
10	4.1		0.61	1.75	-0.82	2.25	-0.71
	6.4		0.61	1.75	-0.76	2.22	-0.74
	10.1		0.61	1.80	-0.76	2.26	-0.75
35	4.1		1.06	1.83	-0.71	2.58	-0.67
	6.4		1.06	1.72	-0.65	2.40	-0.55
	10.1		1.06	1.79	-0.86	2.68	-0,81
60	4.1		1.36	1.69	-0.62	2.54	-0.57
	6.4		1.36	1.79	-0.78	2.85	-0.63
	10.1		1.36	1.88	-0.81	2.97	-0.66
TRIANGLE		6					
10	5.4		1.03	1.67	-0.62	2.31	-0.77
	9.0		1.03	1.64	-0.57	2.23	-0.75
	14.3		1.03	1.75	-0.65	2.41	-0.90
35	5.4		1.55	1.82	-0.68	2.88	-0.80
	9.0		1.55	1.75	-0.65	2.76	-0.81
	14.3		1.55	1.82	-0.55	2.68	-0.73
60	5.4		1.84	1.74	-0.52	2.70	-0.66
	9.0		1.84	1.74	-0.61	2.87	-0.73
	14.3		1.84	1.93	-0.71	3.23	-0.72

APPENDIX B, TABLE 1. Parameters of regression lines for log glare recovery time (sec) as a function of log contrast with resolution as the endpoint criterion. A total of 15 subjects participated in glare recovery determinations in the dark using resolution as the endpoint. Target motion was sinusoidal through an amplitude of 6.5 degrees for the first group of 9 subjects and triangular; that is, constant velocity, through an amplitude of 10 degrees for the second group of 6 subjects. The methods of data collection for this experiment were identical to those described in the main text.

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