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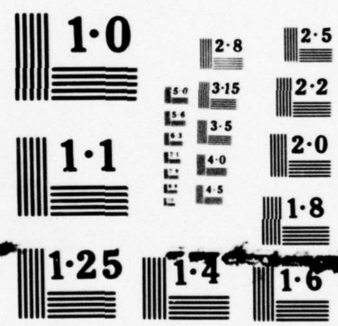

NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

ROYAL AIRCRAFT ESTABLISHMENT

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CAN ATTENTION BE DIVERTED?

by

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Research Inst. of National Defence, (FOA-2-C-2482-H5), Stockholm, 1971

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AUTHORS' SUMMARY

Problem: If two objects of similar shape but different contrast are searched for in a cluttered environment, (a) how much difference in contrast is needed for the object with the greater contrast to be detected first, and (b) does detection of the first object cause delay in detecting the second object?

Method: Two experiments were carried out with the aid of a tachistoscope. One with the objects placed in a cluttered environment and the other with the objects in a terrain background.

Result: (a) It is possible with a high level of probability, to direct an observer's attention towards the desired objects, (b) A delaying effect can be demonstrated but many other factors are capable of interfering with it.

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The problem, in general terms

The following investigations originate from military problems using sham constructions, within the limits of visual observation. It assumes that sham military objects should fulfil the following requirements:

(a) They must be readily detected. A sham object which cannot be detected serves no useful function.

(b) They must be cheap to construct, *ie* they will be as simple as the situation allows.

(c) They must divert attention from the actual target as much as possible.

(d) They must appear sufficiently realistic when observed from a specified distance, to be mistaken for the real object.

These requirements can readily be reduced to certain simple psychological factors. These are dealt with in the investigations, bearing in mind points (a) and (c), and aim to explain the relationship between contrast and time for detection as well as problems associated with delay.

Since there exists an obvious relationship between contrast and time for detection (see for example, Smith, 1961) it seems clear than one can influence an observer's time for detection by varying the objects contrast. If one desires to direct attention to a sham object, one can increase its contrast with the background. On the other hand of course, the contrast must not be too great or the planned diversion of attention from the real object becomes obvious. The actual information the observer obtains in such cases should at best, bring about an immediate break in his observation towards the real object. His task has been *made simpler*; the sham object has counteracted the acquisition of the real target.

The ability to divert attention depends on the available observation periods. The shorter such periods are the more important a rapid diversion of attention becomes and the greater the contrast should be. It is also probable that the requirements for the sham object vary with the situation. Perhaps a simple delay effect is enough for short observation periods; however for longer observation periods the similarity with the actual object must be sufficient for it to be mistaken for the real object.

The question of the feasibility of diverting an observer's attention has, so far as is known, not yet received any great interest within experimental psychology. It seems reasonable to assume that at least two factors are capable of bringing about such diverting effects.

(a) The mere fact that one object has greater contrast than another and thereby draws the observers' attention, means that detection of the other object is delayed.

(b) Upon first detecting the object the observers' attention is retained for a moment, causing a degree of uncertainty about its shape so that he has difficulty in deciding if it is the desired object or not.

The present work only deals with alternative (a). Future reports will discuss other relevant questions, namely the form of the diverting effect and the distance for identification of stylized objects.

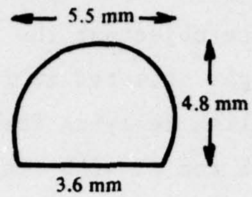
Experiment 1

Questions were first posed concerning the following situation: If two objects of the same shape are masked in a cluttered background so that the light contrast of one of the objects is constant and the other is variable, does the detection frequency of the constant object vary as a function of the other objects contrast? Can one speak of a diverting effect, and in such a case does it vary with the contrast?

As an initial experiment to examine this problem, a trial was carried out using abstract material. Twelve cards were prepared for exposure in the Scientific Prototype's three channel electronic tachistoscope. About one hundred small round discs, punched from Hesselgren's bastard paper series number 3, were glued onto each white card. Up to three similar discs from which a segment had been cut were placed randomly amongst these. The hues of these segments varied as follows.

Card No.	Shade of grey on clipped discs
I	1 of No.3 (reflection capacity *ca* 58%)
II	2 of No.3
III	1 of No.3 + 1 of No.5 (ref. cap. *ca* 47%)
IV	1 of No.3 + 2 of No.5
V	1 of No.3 + 1 of No.6 (ref. cap. *ca* 42%)
VI	1 of No.3 + 1 of No.8 (ref. cap. *ca* 34%)
VII	1 of No.3 + 1 of No.10 (ref. cap. *ca* 28%)
VIII	1 of No.3 + 1 of No.12 (ref. cap. *ca* 23%)
IX	1 of No.3 + 1 of No.16 (ref. cap. *ca* 16%)
X	1 of No.3 + 2 of No.16
XI	1 of No.3 + 1 of No.24 (ref. cap. *ca* 7.4%)
XII	2 of No.3 + 1 of No.24.

The dimensions of the experimental discs are given in the figure below:



The tachistoscope displayed the cards at a distance of 1.25 m. The clipped segments of the discs were then 2 × 10 arc minutes and although visible, were not too easy to find.

Procedure for experiments

The experiment was performed by 20 subjects all employed by FOA. Their visual acuity was measured by means of an orthorater and the experiment was continued with only those subjects giving satisfactory results. The following verbal instructions were then given in connection with card No.XII which was shown upside down.

"Look through the apparatus. You will see a number of round points. If you look carefully you will find that some discs are not complete but clipped. Try to find these and indicate where they are located.

Is that clear?

Now I shall show you some more pictures of the same type. First I will show you the pictures for a short time and then for a much longer time. For each presentation you will be required to locate the clipped dots and say where they are.

I will say "now" for each presentation."

As an aid for pinpointing position, a system of numbered squares were shown immediately after every flash exposure. The following exposure times were used according to the subject's ability: 2, 4, 8, 16, 32 and 64 seconds. Exposure duration increased until the observer found and correctly located the objects.

Results

The exact time for detection was not measured. This short series was designed so that as the experimental discs became darker, the more conspicuous they became and thus more detectable. The interest in the work was accordingly concentrated on the number of exposures (and therefore the approximate times of exposure) required to detect the object in shade number 3. Table 1 sets out the frequencies for first detection during respective viewings. For example, four of the 20 subjects detected the object at the first exposure of card 1 which only had one object of shade 3; eight detected it first on the second exposure, and so on. If one tries to establish delaying factors, a comparison should be made between the results of cards I and II with the remainder.

On the basis of the table's frequency values one can draw normalized cumulative frequency curves (*eg* two examples on page 22). By assuming that the actual detection times are equally distributed within the classes, curves can be used to read off approximate median values and Q_1 and Q_3. These values have been included in Table 1. They are also illustrated in the block diagram on page 23.

The results of detection experiments are rarely clear or easy to interpret. This material is too small and irregular to permit meaningful statistical analysis. Nevertheless, the following observations may be made:

(1) Delay seems to be present (card V, VII and IX have resulted in much longer detection times for grey shades 3 than card I where there was no distraction).

(2) Objects with very strong contrasts (card XI) did *not* divert attention, on the contrary one did not need to search in their vicinity.

The objects were placed randomly and were relatively wide apart from each other. In too many cases (cards V, VI, VIII and XI) they were placed in opposite quadrants (1 and 3, 2 and 4). In at least three of these cases the times for detection were short, perhaps due to a natural search tendency. When an object is located in one quadrant (*ie* Q2) then the subject's natural tendency is to immediately search the opposite quadrant (*ie* Q4). This may be a serious source of error.

The experimental method does appear to be useful although if the trials are to be repeated then the following should be considered:

(a) increase the number of cards tenfold,

(b) limit the number of shade levels for distraction, to three,

(c) place the object in the quadrants, in accordance with a random table.

Experiment 2

Experimental material

The paper screens were photographed in the FOA2 terrain model, scale 1:500.

The screens' dimensions were 2 cm × 1.2 cm which corresponds to an actual object size of 10 m × 6 m. The following papers, all treated, were selected from Hasselgren's grey scale:

No.18 M	about 13% reflection capability
No.16 M	about 16% reflection capability
No.14 M	about 20% reflection capability
No.10 M	about 28% reflection capability
No.1 M	about 73% reflection capability .

Test photographs showed that although subjects were generally able to detect contrasts in papers 16 and 18 this was not achieved without some degree of difficulty. They also showed that with this size of object, one can conveniently simulate a real observation distance of 3000 m. The breadth of the real search sector will then be about 380 m. The pictures were taken so that they corresponded to reconnaissance from the air at about 15^{o} angle downwards.

In all, 44 pictures in black and white were taken and copies reproduced on half matt paper, of suitable dimensions, for the tachistoscope. All these copies were initially used during the main experiment. However, as this experiment proceeded, it appeared that some gave very poor detection results and were omitted in further trials. The experiment was finally conducted with the 34 pictures described in detail in Table 2. It will be seen from the table that the pictures can be divided into two series; pictures with one object and pictures with two objects. The latter series consisting of pictures with a light and dark screen, placed at such a distance that both were never able to fall within the area of the fovea simultaneously. In the former series of pictures only the darker type of screens were used. Two examples of the pictures used are given on page 25. The upper picture reproduces picture No.31 where both screens are easy to detect, and the lower picture No.37, where the higher screen has a median value of 38.6 seconds. Luminance measurements were made on the prints by means of a Spectra-Pritchard telephotometer. The measurements were partly on the object and partly on the immediate surroundings. The choice of method is conditioned by the object screens which were so small on the prints that no other available method could give satisfactory results. The method gave relative luminance measurements suitable as a basis for calculating contrasts.

When it was also of interest to have the objects' reflection value, a luminance measurement was calibrated with a reflectance measurement on a larger homogeneous surface. With this to start with, calculations of the reflectance measurements were made (see Tables 2 to 5). In those cases where the immediate surroundings had very unequal luminance, maximum and mimimum values were measured. On the basis of the values obtained calculations of the contrasts were made expressed in terms of the modulation M.

Carrying out the experiments

The pictures were viewed on the tachistoscope in a random order which varied for each subject. Each of the subjects operated the exposure duration themselves. When ready the subject pressed the button which was depressed until the subject had located a screen. On detecting a screen the subject immediately released the button. The picture was then replaced by a grid which the subject could readily indicate the object's position. A chronometer was triggered off when the button was depressed and was stopped when the button was released; in this way the detection time was measured. When the picture contained several objects, the subject pressed the button again and afterwards recorded the time and verified the indicated positions, in doing so the picture was exposed once more and the chronometer started without first having to be reset to zero. The subject could then continue the search for the other objects and a total search time for this could be read when he again released the button.

Before the real experiment began subjects were familiarised with the experimental procedure by means of practice trials (three pictures which were not used in the experiments reported here).

The following oral instructions were given: "You will see some pictures which look like this (the person looks through the tachistocope and sees a picture with several screens). You see the picture of a landscape in which screens are displayed. Here are the five screens but in the real test there will only be one or two. *Your job is to try to find the screens as quickly as possible and indicate their position.* You see that the screens have different contrasts. Some will be easy to find, others difficult, perhaps impossible. How many can you see in this picture?

This is the procedure: when I have inserted a new picture and say all clear, you are to press the button (demonstrated). Then the picture appears. *Keep the button depressed* until you find a screen. As soon as you are certain that it is a screen release the button, but keep in mind the position of the screen. A localizing grid then appears and you can say where the position is, *eg* B3 or A4 *etc*. If there is still a screen on the picture, wait until I have recorded the time and say 'clear' and then press the button once more. Should you be unable to find any more the picture will be withdrawn after two minutes and replaced by a new one. Some of the screens are very difficult to find so search carefully. All the screens are the same size and the same shape. However, because the distance from the camera differs, so the size will vary. Some are partly hidden by trees and bushes. The greater part of the contour is always visible.

Always remember to release the button *as soon* as you find a screen. Never wait while you look for another one.

We will now practice with a pair of pictures, any questions?"

Seventeen subjects took part in the experiment of which ten were serving their National Service with FOA. The experiment was conducted as part of a series of experiments with two other trials. Prior to the tests those taking part were subjected to sighting tests by means of an orthorater. Only two had subnormal binocular vision although this did not affect their participation in the experiment.

Results

For every object there should in principle have been 17 detection times. However since some subjects did not detect all of the objects this was not always the case. Furthermore, most of the distributions were very 'oblique'. Because of this the results are not suitable for presentation as mean values, but median values have been chosen. These values are given for each screen in Table 2 together with the Q values from which one can derive an understanding of the distribution. The screens are arranged in the table in the order of increasing reflectance against the standard screen.

It is not possible to give a complete explanation of the results of detection in these experiments, partly because of the limited nature of the material and partly because of the many types of uncontrolled variables.

(a) We used paper screens with well defined reflectance levels and hoped to get photographic prints of corresponding levels. The distribution however, was large and affected the reflection levels uniformity.

(b) The distances between the object and the camera varied to some extent.

(c) Picture interpretation trials have shown that the probability of detection does not only depend on the proportion of contrast but also on the position of the object in the picture, for example, from the edge of the picture, position in relation to the characteristic terrain subject and the complexity of the background *etc*.

(d) Measurements of contrast values were derived from the reflectance values within very small measuring distances (about $1\ mm^2$). It did not result in very good correspondence with human contrast experience, which is certainly based on integration over larger territories.

Accordingly, the following discussion is limited to the following two questions:

(a) What is the connection between the reflectance of the object and its contrast to the time for detection?

(b) Can one establish any delaying effects?

1 The connection between reflectance/contrast and time of detection

A question which might be asked is whether there is a minimum degree of contrast which gives at least 50% detection probability. This material shows such a limit may be observed in the region of 0.090 M but that this limit is affected by other factors. Under good conditions contrasts as low as 0.048 M may be detected (picture 24) whilst under unfavourable conditions contrasts of 0.276 M may not be detected, (picture 30). Four screens with contrasts between 0.090 M and 0.100 M have been detected whilst three screens with contrasts between 0.070 and 0.090 M have not.

For each screen we have the value of reflectance, minimum contrast and maximum contrast. One way to obtain an expression for the relationship between these values and the results of detection is to calculate their correlation. Since the median values have been selected to express detection results, the connection can be calculated by means of the precedance correlation (see Garrett, 1953, pages 354-356). The following values were obtained:

$\rho = -0.57$ between reflectance and detection time (significant at 0.01 level),

$\rho = -0.435$ between lowest contrast value and detection time (significant at the 0.05 level),

$\rho = -0.24$ between the highest contrast value and detection time (not significant).

One can accordingly demonstrate that the greater the reflectance possessed by a screen the shorter the probable detection time and equally that as the contrast increases detection time decreases. Nevertheless no correlation value is especially high. This may be the result of numerous disturbing factors. That the contrast values become lower in relation to the reflectance values may depend on the above condition, or that the background has rarely been uniform and that only very small parts become the subject of measurements. Maximum contrasts have given worse results than the minimum contrasts, which may be a result of the fact that only small parts in the neighbourhood of the object were, as a rule, dark.

The table below shows the picture reflection and minimal contrast values, together with the detection times.

Reflectance	Minimum contrast			
	Lowest		Highest	
	Number pictures	First detection	Number pictures	First detection
Highest	7	17.4%	16	63.3%
Lowest	16	8.3%	7	11.0%

In 16 of the 23 pictures, the correlation between the measured reflectance and the contrast values were positive, and in these cases 63% of detection times were shortest for the object with the highest values. In only 8% of the cases did the subject first detect the screen which was both the darkest and had the least contrast. In those cases where reflectance and contrast were in opposition 17% of the cases were in reflection and 11% in contrast.

A more detailed interpretation of the relations between reflectance, contrast and detection time can be obtained by studying Tables 3 and 4. Here only those pictures with two screens were taken into account. In the first column of Table 3 the differences in reflectance between both the screens on each picture have been grouped. The N value in the next column is the number of pictures with the corresponding reflection difference multiplied by the number of persons (17). Column 3 states the number of cases in which the lightest screen was detected first and column 4 gives the mean value of the times when the lighter screen was detected earlier than the darker screen. It was found that with very low reflectance levels, the lightest was detected first in only 37.6% of the cases, and so the mean times were not calculated. For the remaining reflectance levels, the lighter screens were detected 7 to 16 seconds before the darker in over 80% of cases: any uniform increase in these values in connection with increased reflectance cannot however, be established. Column 5 gives the number of values which failed because the subject only detected one of the screens.

Table 4, column 1 gives a corresponding classification of the differences in minimum contrast values. In all levels but one, we find (column 3) that the greater the contrast the shorter the detection time (the differences have fallen between 9 and 17 seconds according to column 4) but that the probability for prolonged detection times is not clearly related to the contrast differences.

The first question asked may now be answered. *It is possible with a high level of probability to direct an observer's attention towards the object one desires.* The first requirement of a sham object can be fulfilled, namely the requirement that it will attract the observer's attention.

2 The delaying effect

The second requirement of a sham object may be said to be to retain the observer's attention as long as possible and thus delay his detection of other objects. This requirement is thought to be attainable by several different means. The question posed in this investigation, confined to its most simple terms, asks if such a delay can occur automatically, by the fact that the most visible object is detected first?

The picture material used was not as suitable as had been hoped for in answering this question. The original plan was to compare detection times for:

(a) individual screens on a certain contrast level with,

(b) screens on the same contrast levels which combined with,

(c) another screen which had greater contrast against the background.

If the detection time for the (b) screens were significantly longer than the (a) screens then one would have established such a delaying effect. Since the (a) and (b) screens must possess the same reflectance level, the material used in the experiment becomes suspect because of diffusion introduced by the photographic process.

Tables 5 and 6 give the results that have been obtained. Table 5 compares the detection time for individual screens with reflectances between 39 and 48% with the time for similar screens in combination with lighter screens. In the column farthest to the right it will be seen that we can often demonstrate a delay, but with no regularity. The table consists of only six individual and ten combined screens.

Table 6 is based on corresponding calculations for the contrast values and it suggests that if screens of minimum contrasts below 0.250 M are combined with screens of higher contrast levels the time for detection is, as a rule, *not* longer than the corresponding time for a single screen. Longer times have however, been obtained in a few cases where the distraction screen has very high contrast.

For comparison purposes we calculated the mean values of the detection times for all individual screens and all darker screens respectively on dual pictures. In the first case, N = 146, later 24 cases of failures were withdrawn and in the latter case N = 366 with 42 failures withdrawn. The mean value in both cases was 12.5 seconds. With this rough method of calculation however, no delay could be established.

If instead, one divides up the later category of pictures into groups and set them out after the distracting screen's reflection values (before they are photographed), one obtains the following values:

	No. cases	Number of failures	Detection time (mean value)
Individual screens. Shades 16 or 18	146	24	12.5 s
Shades 16 or 18 + shade 14	143	10	13.9 s
Shades 16 + shade 10	107	12	10.6 s
Shade 16 + shade 1	87	15	15.7 s .

One can find no systematic connection between the time for detection and the distracting screen's reflection value.

No significant calculations have been made on the material presented. By way of summing up one can say no sure delay effects could be established by this method but that possibilities are forthcoming.

Unfortunately the experimental procedure did not allow the measurement of delay effects. It is not therefore possible to get an exact understanding of the delay effect if one does not know how fast the eye is drawn towards a sham object and how long it is retained in its vicinity. It is also highly desirable that the experiment is conducted in a way that allows it to be complemented by recordings of eye movement. It will then be desirable also to increase the search area (the angle has been unrealistically small) and increase the sample of picture material (bearing in mind the large diffusion which happens in search experiments of this type).

Table 1

How many test people during their respective viewing detected the object for the first time, with grey shade No.3?

Card No. \ View No.	1 2 s	2 4 s	3 8 s	4 16 s	5 32 s	6 64 s	Mean	Q_1	Q_3	Distraction shade
I	4	8	6	2			3.0 s	2.2	7.2	
IIa	6	6	3	2	2	1	4.5 s	1.9	15.0	
IIb	3	8	6	1	2		4.5 s	2.5	11.2	
III	7	5	5	-	3		3.9 s	1.8	12.0	5
V	4	5	6	3	1	1	6.5 s	2.5	15.0	6
VI	5	7	5	2	1		4.0 s	2.0	10.0	8
VII	2	5	7	6			8.5 s	4.3	16.2	10
VIII	6	6	3	4		1	3.9 s	1.9	13.0	12
IX	2	7	5	4		2	7.1 s	3.5	18.0	16
XI	5	8	2	4	1		3.3 s	2.0	11.5	24

Table 2

TRIAL MATERIAL AND DETECTION TIMES

Picture No.	Position of screen in grey scale	Reflectance %	Minimum contrast $M = \frac{\rho - 1}{\rho + 1}$	Maximum contrast $M = \frac{\rho - 1}{\rho + 1}$	Detection time in seconds (mean of 17 values)	Q_1	Q_3
4	16	33	0.171	0.478	54.6	14.6	-*
41	18	39	0.096		5.6	3.3	14.6
42	18	41	0.200		13.8	8.6	27.0
6	16	42	0.194	0.686	7.5	4.2	12.4
3	16	43	0.098		6.4	3.2	13.2
7	16	44	0.227	0.586	5.1	3.2	29.4
43	18	44	0.122		31.9	16.4	-
8	16	49	0.172		27.0	10.5	52.6
5	16	53	0.774		4.7	3.3	10.7
2	16	55	0.374		2.7	1.7	8.0
9h	16	27	0.366		12.9	7.8	-
v	16	47	0.273		2.8	1.8	4.2
35h	16	28	0.135	0.706	19.8	7.2	23.9
v	1	85	0.517		2.1	1.4	3.5
11h	16	29	0.277		8.4	5.3	14.6
v	16	48	0.135	0.724	2.5	2.0	3.6
26h	16	29	0.277		7.0	3.8	15.7
v	10	52	0.479	0.770	3.6	2.1	8.2
33h	16	29	0.091	0.579	7.3	3.7	21.8
v	1	81	0.273	0.787	1.8	1.6	4.1
38h	18	31	0.123		4.5	2.7	7.3
v	14	58	0.464		1.7	1.3	2.2
14h	16	36	0.396		9.9	4.6	18.9
v	14	52	0.301		18.9	7.8	34.9
15h	14	36	0.289	0.721	4.2	2.2	8.8
v	16	41	0.167	0.714	15.0	4.9	41.2
22h	16	38	0.368	0.733	4.0	2.9	7.6
v	10	63	0.238	0.398	1.9	1.1	3.2
37h	18	38	0.093		38.6	7.8	-
v	14	57	0.457		2.8	1.5	3.7
13v	16	39	0.159		1.9	1.4	4.9
h	14	44	0.333		8.0	4.5	14.7
29h	16	39	0.143	0.739	6.5	4.7	20.4
v	1	82	0.371	0.667	2.0	1.4	2.7
31h	16	41	0.474	0.647	3.6	2.6	4.9
v	1	80	0.444		1.3	1.0	1.9
39h	18	41	0.235		4.1	2.6	7.6
v	14	63	0.368		2.3	1.4	3.5
24h	16	42	0.048		18.9	10.3	-
v	10	77	0.633		1.6	1.2	3.4
27v	16	42	0.189	0.796	4.2	2.7	7.2
h	10	72	0.293		1.6	1.1	3.6
17v	16	44	0.108	0.736	26.0	9.4	-
h	14	46	0.412	0.466	2.0	1.2	3.8
21v	16	45	0.190	0.541	36.0	5.4	59.2
h	10	68	0.261	0.772	1.7	1.3	4.4
19h	16	46	0.746		8.4	4.7	34.5
v	14	50	0.143	0.705	5.6	3.4	11.2
28v	16	46	0.315		2.9	2.1	5.2
h	10	74	0.439		4.6	1.9	5.4
34v	16	46	0.371		40.2	20.2	-
h	1	82	0.382		2.3	1.4	3.2
36v	16	46	0.391		25.8	10.9	-
h	1	67	0.423		1.2	0.9	2.9
20v	16	53	0.209		1.7	1.2	3.8
h	14	56	0.184	0.415	14.5	6.4	21.2
23v	16	59	0.232		11.8	7.7	20.6
h	10	80	0.239	0.785	1.8	1.0	2.4

* means that at least four people did not detect the screen.

Table 3

Differences in detection time for pictures with two screens (only those cases are included where both screens were detected). N = number of pictures × number of people (= 17).

1	2	3	4	5
Difference in reflectance %	N	In how many cases have the lightest (which also has the highest reflectance) been detected first?	How much earlier? (M of s)	Number of cases where only one screen was detected
2 - 18	102	37.6% (35 of 93)		9
19 - 28	187	85.5% (141 of 165)	11.5 s	22
29 - 38	51	92.7% (38 of 41)	15.9 s	10
39 - 47	34	97% (32 of 33)	7.1 s	1
48 - 57	34	82.8% (24 of 29)	12.2 s	5

Table 4

Differences in detection time for pictures with two screens. N = number of pictures × number of persons (= 17).

1	2	3	4	5
Difference in minimum contrast (M)	N	In how many cases has the screen with the greatest contrast been detected first?	How many earlier? (M of s)	Number of cases where only one screen was detected
0.000 - 0.099	136	73.7% (84 of 114)	16.0 s	22
0.100 - 0.199	136	46.1% (59 of 128)	8.7 s	8
0.200 - 0.299	34	90.9% (30 of 33)	9.3 s	1
0.300 - 0.399	68	93.0% (53 of 57)	16.9 s	11
0.400 -	34	62.1% (18 of 29)	11.9 s	5

Table 5

TIMES FOR DETECTION WITH AND WITHOUT DISTRACTION
(WITH APPLICATION OF *REFLECTANCE* VALUE)

Where screen with reflectance value of 39-48% are combined with screen with following reflectances	N	Thus the time for its detection is: (med of s)	Corresponding detection time for individual screen with reflectance 39-48%	Delay in seconds
48 - 57	17	8.4		1.4
58 - 67	34	15.0	7.0 s	8.0
68 - 76	51	4.2	(N = 102)	-
77 - 86	68	12.7		5.7

Table 6

TIMES FOR DETECTION WITH AND WITHOUT DISTRACTION
(WITH APPLICATION OF *CONTRAST* VALUES)

If the screen with contrast = 0.00-0.249 M is combined with screen with the following contrasts	N	Thus the detection time is: (med of s)	Corresponding detection time for individual screen with contrast 0.00 - 0.249
0.250 - 0.499 M	204	5.3 s	10.7 s
0.500 - 0.750 M	51	18.9 s	(N = 136)

LT 1936

REFERENCES

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Smith, S.W. Time required for target detection in complex abstract visual display. Inst. of Science and Technology, University of Michigan, Ann Arbor, Mich, 1961.

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Section 264 placed the terrain model at our disposal for photographing the objects.

Photographer G. Sörlin carried out the photography and printing services.

C. Ågren made contrast measurements by means of a photocopier.

Ten volunteers served as experimental personnel.

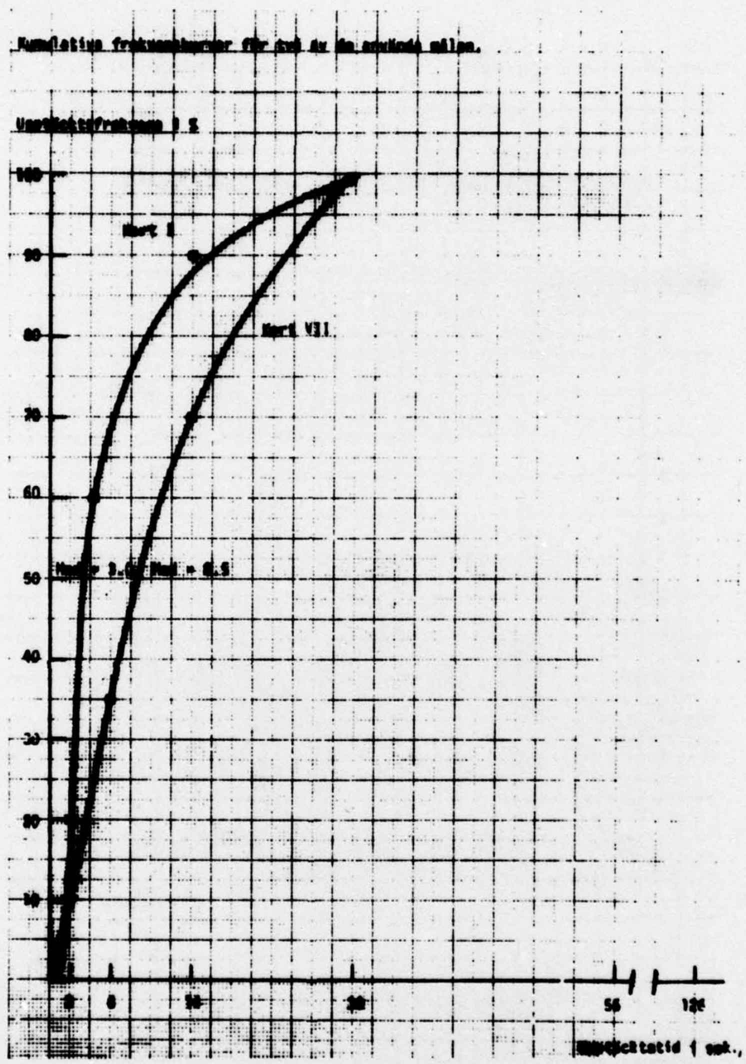

Fig 1 Cumulative frequency curves for two of the objects used

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Fig 2

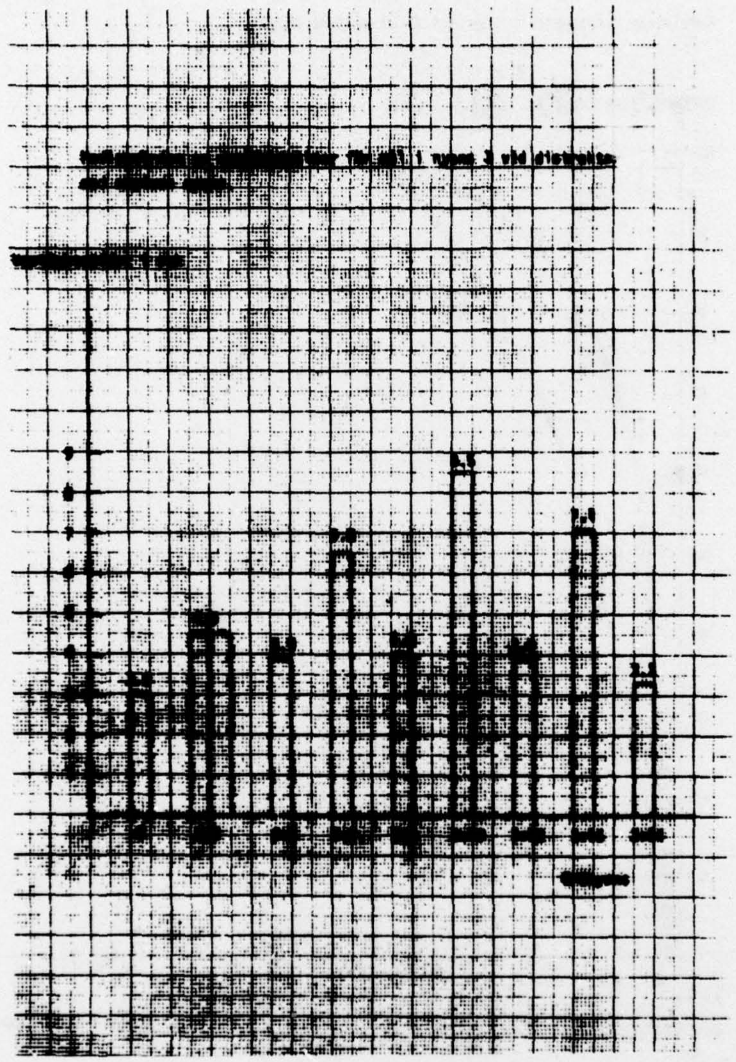

Fig 2   Median values of detection times for objects
in shade 3 with distractor of stated shades

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Fig 3

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