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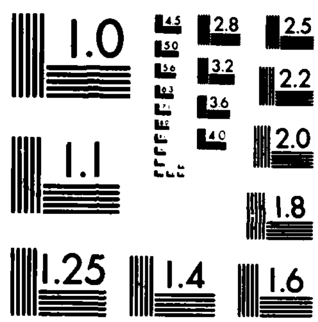

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MELBOURNE, VICTORIA

REPORT

MRL-R-893

A PRELIMINARY ASSESSMENT OF OBSERVER EXPECTATIONS IN TARGET DETECTION TASKS

C.J. Woodruff & G.S.M. Webb

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The determination of soldiers' expectations as to what target features would cause detection of stationary M113 vehicles was examined. Results show that a scenario procedure is appropriate. A factor analysis of the expectations scales isolated four factors underlying the communality of these scales; however there is considerable unique variance associated with each scale. The interpretation of these factors is discussed, and modifications to the scenario scales for future use are outlined. Results of an attempt to collect data on actual causes of detection during a live exercise show that such data cannot be effectively gathered under these conditions.

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CONTENTS

A PRELIMINARY ASSESSMENT OF OBSERVER EXPECTATIONS IN TARGET DETECTION TASKS

1. INTRODUCTION

Camouflage research has been largely concerned with modifying targets so as to increase the correlation between the physical properties of the target and those of its background. This approach has produced much improvement in camouflage materials. However, military detection and recognition processes are currently heavily dependent on the functioning of the human visual perceptual system, and such will continue to be the case even with the development of more sophisticated technology. Furthermore, human visual functioning is affected by culture, motivation, and training. It is therefore appropriate that research on camouflage involve not only a knowledge of the neurophysiological laws of visual performance, but also an awareness of how cognitive factors in the observer affect performance.

It is a truism that those who know what they are looking for are more likely to find it than those who aren't too sure. Likewise, looking for the wrong thing reduces the chances of finding the right thing. These simple ideas will apply to the search for military targets. Specifically, if a searcher expects certain features to be key cues to detection of a target, then one would predict performance to depend on whether or not that feature was present in the target, or the extent to which it was discernible. Thus an interaction between feature discriminability and observer expectation level for that feature may be a determinant of search performance. Also, if an observer expects a particular target feature always to be a major cause of detection when, in fact, its discriminability varies considerably with respect to other features, then his search performance would be more adversely affected by variability in this feature than would that of observers with less rigid expectations. Thus, both the level of expectation of certain features and rigidity of that expectation ought to affect search performance. To be able to examine any such effect it is necessary to devise a measure of search expectations.

This report describes preliminary work directed towards development and assessment of a self-report methodology for determining the expectations of Australian soldiers as to what perceptual cues they would use in detection tasks, and also towards determining the cues actually used. Field data were gathered in an Australian Army exercise (Exercise "Flashing Sabre", held in the Cobar region of New South Wales, April-May 1982). This was a reconnaissance-type exercise run by 2 Cavalry Regiment with both friendly and enemy forces operating in M113 vehicles over a period of 8 days, 24 hours per day. A total of 32 vehicles were active in reconnaissance (24 friendly, 8 enemy) operating in an area of approximately 10,000 square kilometres. The enemy's movements were under central control. There was only a limited chance of contacts most of the time and considerable distance to be covered by each vehicle. There were usually 2 or 3 potential observers per vehicle.

In a review of studies on self-reports as a source of information on cognitive processes Nisbett and Wilson [1] show that such reports are often inaccurate. However, their evidence suggests that, even though inaccurate, these reports are regular and systematic. The reviewers argue that the basis of these systematic reports is the observer's *a priori* causal theory of a relation between events. Hence these self-reports provide information on what the particular observer believes are his processes irrespective of whether this is actually the process he uses. In the present situation we are seeking information which is closely related to what the subject believes underlies his actual behaviour. Hence, in accord with Nisbett and Wilson's argument, we believe that self-reports of expectations are probably accurate when they are consistent.

The question of usefulness for predictive purposes, however, is not dependent on the accuracy of such reports but only on their reliability and degree of correlation with subsequent performance. Hence, for the remainder of this report, it will be assumed that the self-reports do, in fact, provide accurate information on expectations. A further study has been planned to examine the relation between reports of expectations and actual search performance.

2. PROCEDURE

The data gathering was directed towards comparing individual observers' expectations with their subsequent reports of actual causes of detection of enemy vehicles or personnel, and this was to be followed by individual interviews which would focus on any mismatches between expectations and reports. Unfortunately, the report data obtained were quite inadequate for meaningful analysis along these lines, and so this plan was abandoned. The proposed final interview was replaced by a modified form of expectations report whose format was derived from a preliminary analysis of the first questionnaire on expectations, and from pooled experiences of the experimenters on the exercise.

The data gathered, then, consisted of 3 sets:

i. expectations, from the initial questionnaire;

ii. reported causes of actual detection;

iii. expectations, from the final questionnaire.

In the following sections the results from each of these parts are presented and discussed. Subjects were A and B squadrons of 2 Cavalry Regiment, and 17 members of 1 Armoured Regiment. We refer to these as A, B and C groups respectively.

3. THE INITIAL QUESTIONNAIRE

The initial questionnaire consisted of 13 items, each to be answered for 3 separate conditions of the target (see Appendix 1). The items were derived by reference to established army surveillance teaching regarding causes of detection, with additional items based on suggestions of experienced field trials personnel. Items were vetted by army personnel with a wide range of experience, including ground combat. For each item - describing a possible cue to detection - the subject indicated expected usefulness for detection in one of the five categories - no use, little use, moderately useful, very useful, extremely useful. Piloting work had indicated some problems would arise with some subjects in interpreting the instructions. Amendments were made to the instructions to clarify certain points, but it was realised that concise written instructions would not be entirely adequate. Hence, in the actual administration any one of three experimenters gave a partially standardised verbal explanation in addition to the written instructions. During the filling out of the questionnaire subjects worked independently of others. A further check on subjects was provided by their answer to Item 9 under the stationary conditions; subjects were checked as they filled out the questionnaire, and those who indicated anything other than "No Use" to Item 9 were queried, and directed to check their previous responses. This apparently helped most of those who were still a bit confused about what was required.

After the questionnaire had been administered on a one-to-one basis to an initial group of 17 subjects, it was decided that it could be administered on a group basis to the remaining subjects. This was done with 3 experimenters per troop (approximately 15 subjects), and no difficulties were apparent. Ninety subjects responded to the initial questionnaire - 46 from group A, 35 from group B, and 15 from group C.

In analysing the data it has been assumed that the differences between response scores are directly proportional to the underlying differences in expectations measured by these scores. The response scores used in the analysis are obtained by averaging responses across subjects, i.e. using summated responses. Treating summated responses as providing a scale appropriate to the use of parametric statistics has been discussed extensively in the literature [2-4], with the weight of opinion supporting the assumption that parametric statistics are appropriate when using summated responses which give approximately normal distributions. For the data obtained in this work the distribution of responses on items taken over the three groups showed deviations from normality which were significant at the .01 level (d'Agostino, 1970) for items 9 and 13 under the three conditions, and items 4 and 8 only in the stationary uncamouflaged case. Such deviations are, in all cases, associated with "ceiling" effects and thus can be treated as reducing the differences between response means and hence the power of tests of mean differences. The item response data have therefore been treated as being from normal distributions on interval scales.

Items were scored 1 = No Use, 2 = Little Use, ... 5 = Extremely Useful. Tables 1 to 3 provide means and standard deviations on all items for the total population, and for each group under the three target conditions. The order of items is based on means for the total population, from most useful to least useful in each table. Product-moment correlation coefficients between individual subject responses of the total population on items are given in tables 4 to 9 where these were of magnitude greater than 0.18. Significance values are not listed since their calculation assumes independent responses, and the pattern of correlations suggests a strong sequential effect in responses.

The differences in response patterns under the three conditions provide confirmation of the validity of this method of data collection. However, the sequential response pattern makes quantitative analysis unreliable. A further point is that comparison of item means across conditions is inappropriate because of the confounding in responses of absolute likelihoods of detection with relative usefulness of specific features. This confounding is seen in the generally lower responses in the "net" condition compared to the "no net" condition.

Because of these limitations in the data, detailed quantitative analysis has not been undertaken. However the following features of soldiers' expectations are noted:-

1. Shape is considered the major cause of detection of stationary vehicles and this is considerably reduced through the use of camouflage nets.

2. Moving personnel around both camouflaged and uncamouflaged (stationary) vehicles are a major cause of detection.

3. Glossy reflections are not considered a likely cause of detection - possibly an artifact of the initial instructions (Appendix 1).

4. Colour and patterning differences between target and background are of significant and comparable importance in either stationary condition.

5. Protruding aerials are a major cause of detection, particularly under the "net" condition.

4. CONTACT REPORT DATA

The format of the Contact Report is shown in Appendix 2. This format was reached after discussions with Major I. Farrant of 2 CAV Regiment, and provided an extension of the regiment's standard report. It was designed to facilitate radio transmission of data and manual recording at both transmitter and receiver ends. However, checks taken during the exercise showed that the additional data were not being transmitted, and were not being routinely recorded during or following contacts. Subsequent to this checking, more data were recorded. However most of this data referred to detection of moving vehicles, and there was too long an interval between detection and the recording by the observer of what he considered to be the causes of detection. Thus there was not enough data, and what there was was of dubious validity.

The major points arising from this aspect of the data collection (based on only 27 completed contact reports out of a total of approximately 80 contacts in the complete exercise) are:-

1. By far the majority of contacts (80% or more) were due to vehicle motion features - dust and noise being discernible well before visual contact is made;

2. Collection of actual contact data on perceptual cues used would require experimenters in the observing vehicle.

5. FINAL QUESTIONNAIRE

The final questionnaire was a further attempt at finding a satisfactory procedure for determining expectations of the causes of detection. A scenario was described and 12 items were to be rank-ordered without ties as to their expected usefulness in causing detection. Ninety seven subjects were administered the final questionnaire, of whom sixty seven had also completed the initial questionnaire. All subjects had completed the reconnaissance part of Exercise "Flashing Sabre" at this stage. Appendix 3 gives the final questionnaire.

For each item the mean and standard deviation of the ranks given by the total population, and by each of the groups separately were calculated (rank = 1 for most useful, rank = 12 for least useful), and these are presented in table 10. Pearson product-moment inter-item correlations of mean rankings given by the total population are presented in table 11. No sequential response effect is apparent. Item response distributions are mostly symmetric but platykurtic (flatter than a normal distribution of the same standard deviation). However, on all items except number 8, values for skewness and kurtosis were similar for the three groups. Hence, for all items except item 8, statistics calculated assuming normal distributions will be meaningful.

The correlational data show a trend toward significant positive correlations between the various shape-type items (1,3,8,9,11) and between the shine-type items (2,4,6,7,12), and negative correlations for shape items with shine items. In interpreting data such as this where, for each subject, the sum of scores is fixed some care is needed. When a subject allocates a high ranking to one item this implies a lower expected value of the ranking for any other item. One effect of this is that the expected value of the correlation coefficients must be negative. For the data from this final questionnaire the average value of all inter-item correlation coefficients is -0.053. Thus it seems that correlation coefficients outside the range (-0.22, +0.12) are significant at the .05 significance level. These are underlined in table 11. Note the positive correlations between similar items (shine-shine, aerials-guns, wheel-wheel), and negative correlations between dissimilar items.

The 12 items used to assess expectations clearly overlap to some extent in what they measure (as indicated by their intercorrelation). Expectations of cues as measured here is clearly multidimensional, but may be described adequately by fewer than the 12 non-orthogonal dimensions. To investigate this possibility the technique of factor analysis is available. Briefly, this technique determines factors which account for the common variance associated with a set of measures. If the number of factors needed to explain most of the common variance is small compared to the number of items then by interpretation of these factors more compact descriptions of expected cues to detection might be available. A more technical description of factor analysis is given in Appendix 4. The factor analysis used here was "classical" factor analysis using principal factors extraction with iteration to estimate communalities, followed by oblique rotation. The five factors after rotation showed only a small correlation (see table 14).

As applied to these data, factor analysis indicated four major non-orthogonal dimensions or factors. The factors are extracted sequentially such that successive factors maximally reduce the residual common variance. Table 12 gives the standardised multiple regression coefficients of items on factors. From this table it can be seen that factor 4 is clearly an overall colour factor, and hence factors 1, 2 and 3 are presumed to be meaningful. Factor 5 may not be meaningful, and anyway only counts for a small percentage of the common variance. Since the low ranking assigned to an item indicates greater usefulness, the sign of weightings is opposite to that of conventional scales.

The other factors can now be interpreted by examining which items load heavily on a particular factor and the sign of these weightings. Factor 1 can be interpreted as "extensive shape/not shine" since items 1 and 8 give substantial negative loadings while "shine" items 4 and 6 give positive loadings. Factor 2 has the items "aerials up" and "mounted guns, etc." loading negatively and "turret shine" loading, positively on it and so may be interpreted as a "protruding lines" or "fine structure silhouette" factor. Factor 3 is conveniently described as a "near-ground shadows" factor, particularly as "wheel shape" loads positively while "bulk" and "ground shadow" (item 8) load negatively. The items with largest weightings on factor 5 are, apart from item 4, those with high (little use) mean rankings (see table 10), and item 4 has comparatively large weightings on all factors but factor 4. This suggests that interpretation of factor 5 is not worthwhile.

The factor analysis presented here used the total population data (97 subjects), since otherwise numbers would be too low. However, it should be noted that analysis of variance showed that differences between the groups were significant on items 3, 5, 6 and 8, and this may affect the resulting factor structure. Also, the factor analysis only deals with common variance. Table 13 lists the total variance of each variable accounted for by the combination of the 5 factors, i.e. the common variance or communality of each variable. It is clear that most variance for each item is common. No reliability data is available for the items, and hence the significance of the unique variance cannot be assessed at this stage.

In appendix 5 an alternative factor analysis is presented, based on extracting factors which explain all the variance rather than just unique variance. The results from this analysis are substantially the same as those presented here.

6. DISCUSSION

Both methodologies investigated here for ass g soldiers' expectations have been useful, but the scenario proced is more satisfactory for quantitative analysis. It is also simpler to implement and brief. The expected causes of detection, as indicated by the results from both forms of questionnaire, show only one surprising feature, the association by subjects of "extensive shape" with "not shine". Subjects apparently perceive bulk as being opposed to shine. This may relate to the functioning of "dazzle" camouflage, and also the operation of other disruptors in camouflage.

The low importance of most of the shine items in the final questionnaire (table 10) suggests that a more compact form of this questionnaire can be produced by combining some shine items. Also items 5 and 11 - dealing with target shadow - were not strongly differentiated, and so can be combined.

7. CONCLUSIONS

A suitable methodology has been developed for assessing soldiers' expectations of the causes of detection. Improvements, based on the significance of certain items and the structure of expectation space, have been proposed.

It has been found that the collection of report data on the visual causes of detection in realistic activities is not a feasible approach to this problem.

Tactical points of interest are that personnel movement is expected to be a major cause of detection of stationary vehicles, and also that protruding aerials are a major cause of detection under net camouflage.

8. ACKNOWLEDGEMENTS

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TABLE 1

Initial questionnaire summary data for NO NET condition

Item No.	Total		A Squadron			B Squadron			1 Armoured		
	Mean	S.D.	Mean	S.D.	Rank	Mean	S.D.	Rank	Mean	S.D.	Rank
4	4.01	1.08	4.11	0.71	1	4.00	1.49	1	4.07	1.10	1
12	3.78	1.18	3.73	1.20	2	3.87	1.22	2	3.73	1.10	3
2	3.30	0.91	3.36	0.68	3	3.17	1.17	3	3.40	0.99	4
7	3.20	1.18	3.18	1.05	5	2.90	1.18	7	3.87	1.36	2
3	3.17	1.06	3.33	1.11	4	3.03	0.91	5	2.93	1.16	7
5	3.07	1.11	3.11	1.03	6	3.03	1.18	6	3.00	1.25	5
6	3.03	1.22	3.02	1.12	7	3.07	1.46	4	3.00	1.07	6
1	2.64	1.08	2.76	0.98	8	2.67	1.24	8	2.27	1.03	10
8	2.34	1.33	2.33	1.07	9	2.17	1.44	9	2.93	1.71	8
11	2.16	1.08	2.13	1.01	10	2.10	1.08	10	2.33	1.29	9
10	1.94	1.14	2.07	1.23	11	2.00	1.11	11	1.47	0.74	12
13	1.70	1.34	1.64	1.38	12	1.62	1.24	12	1.93	1.44	11
9	1.32	0.99	1.27	0.94	13	1.37	1.07	13	1.40	1.06	13

T A B L E 2

Initial questionnaire summary data for NET condition

Item No.	Total		A Squadron			B Squadron			1 Armoured		
	Mean	S.D.	Mean	S.D.	Rank	Mean	S.D.	Rank	Mean	S.D.	Rank
12	3.47	1.26	3.38	1.25	1	3.66	1.37	1	3.40	1.12	1
7	2.85	1.14	3.00	1.07	3	2.67	1.01	4	2.80	1.57	2
2	2.84	1.15	2.87	1.08	4	3.00	1.31	2	2.47	0.99	4
3	2.83	1.27	3.02	1.03	2	2.83	1.51	3	2.27	1.28	6
4	2.46	1.15	2.44	1.04	5	2.37	1.22	6	2.67	1.40	3
6	2.30	1.25	2.16	1.09	7	2.60	1.40	5	2.13	1.36	8
5	2.15	1.16	2.16	1.04	8	2.24	1.30	7	1.93	1.28	9
8	2.14	1.27	2.07	0.99	9	2.07	1.51	10	2.47	1.55	5
1	2.06	1.10	2.18	1.15	6	2.24	1.12	8	1.33	0.49	11
11	2.02	1.10	1.91	1.06	10	2.10	1.05	9	2.20	1.32	7
10	1.52	0.92	1.49	0.94	11	1.69	1.00	11	1.27	0.59	12
13	1.43	1.04	1.33	0.93	12	1.68	1.34	12	1.21	0.58	13
9	1.32	0.86	1.18	0.68	13	1.41	0.91	13	1.53	1.19	10

T A B L E 3

Initial questionnaire summary data for MOVING condition

Item No.	Total		A Squadron			B Squadron			1 Armoured		
	Mean	S.D.	Mean	S.D.	Rank	Mean	S.D.	Rank	Mean	S.D.	Rank
13	4.78	0.86	4.89	0.61	1	4.76	0.83	1	4.47	1.41	1
9	4.58	1.10	4.78	0.67	2	4.52	1.24	2	4.13	1.64	2
11	3.49	1.30	3.58	1.31	3	3.29	1.41	4	3.60	1.06	3
4	3.33	1.24	3.31	1.13	4	3.21	1.32	5	3.60	1.45	4
8	3.09	1.34	3.02	1.32	6	2.97	1.30	8	3.53	1.46	5
3	3.03	1.25	2.93	1.16	7	3.31	1.44	3	2.80	1.08	8
7	2.97	1.29	3.09	1.13	5	2.68	1.36	9	3.13	1.60	6
2	2.94	1.15	2.82	1.19	9	3.10	1.26	6	3.00	0.76	7
1	2.83	1.25	2.84	1.22	8	3.10	1.35	7	2.27	1.03	10
10	2.48	1.29	2.82	1.32	10	2.11	1.03	12	2.13	1.41	12
5	2.26	1.06	2.27	1.03	11	2.29	1.11	11	2.20	1.08	11
6	2.17	1.10	2.04	1.00	12	2.52	1.27	10	1.87	0.92	13
12	1.74	1.20	1.56	1.06	13	1.66	1.14	13	2.47	1.51	9

T A B L E 4

Inter-item correlations on initial questionnaire for NO NET condition

NO NET

		1	2	3	4	5	6	7	8	9	10	11	12	13
	1		.31										.23	
	2			.23	.22									
	3				.28		.30							
N	4					.31	.35	.20	.21					
O	5						.54	.27	.25		.21			
N E	6													
T	7								.51	.26			.30	
	8									.23	.22	.37	.23	.23
	9													.31
	10											.33		.20
	11												.25	.31

TABLE 5

Inter-item correlations on initial questionnaire for NET condition

NET

		1	2	3	4	5	6	7	8	9	10	11	12	13
	1		.44	.37	.21	.43	.34				.20		.19	
	2			.48	.37	.29	.23						.21	
	3				.48	.50	.43	.20						
	4					.63	.51	.24			.18		.19	
	5						.60	.24		.23	.35		.20	
N E T	6										.19			
	7								.39				.25	
	8									.46	.23	.45	.19	.33
	9										.28			.45
	10											.38	.19	.25
	11												.35	.22
	12													.18

T A B L E 6

Inter-item correlations on initial questionnaire for MOVING condition

MOVING

		1	2	3	4	5	6	7	8	9	10	11	12	13
	1		.40	.34		.23	.22			.24				.23
	2			.72	.47	.31	.22	.34	.29	.23				.24
	3				.43	.33	.24	.30	.27	.25				
MOVING	4					.45	.28	.28	.19	.18				.25
	5						.61				.22			
	6										.23			
	7								.77	.40	.30			.23
	8									.29	.32	.20	.24	
	9										.29	.23		.59
	10											.29		.23

TABLE 7

Correlations between corresponding items in NET and NO NET conditions

NO NET

		1	2	3	4	5	6	7	8	9	10	11	12	13
	1	.48												
	2		.32					.22						
	3			.42	.18	.19	.20							
	4													
	5			.24	.28	.45	.34							
N	6			.18	.31	.39	.54				.22			
E T	7				.18			.54	.35				.22	
	8							.37	.68	.23		.28		
	9									.53				.23
	10	.29				.30					.57	.40		
	11								.45			.69		
	12					-.18	-.20		.27				.43	.29
	13								.23			.24		.52

TABLE 8

Correlations between corresponding items on the initial questionnaire under the NO NET and MOVING conditions

NO NET

MOVING	1	2	3	4	5	6	7	8	9	10	11	12	13
1	.18								.24	.24			
2			.18										
3			.42										
4			.22	.33									
5					.30	.30				.25			
6	.21	.21	.20		.32	.38			.21	.18			
7		.32					.45	.24					
8		.25					.37	.28					
9	.29		.37	.31			.43	.23				.48	
10	.19		.23		.20	.25		.28			.32		
11													
12							.25	.19					
13			.27	.21									

TABLE 9

Correlations between corresponding items on the initial questionnaire for NET and MOVING conditions

NET

MOVING	1	2	3	4	5	6	7	8	9	10	11	12	13
1	.20	.25	.24					-.20					
2		.43	.30	.22									
3		.29	.37	.21		.19							
4		.20	.26										
5			.23		.27	.24				.23			
6	.21	.21	.26		.30	.41			.24				.31
7		.23	.22	.29			.49	.21					
8							.40	.27					
9							.27			-.22			
10	.26	.22					.22	.29					
11											.18		
12							.23	.36	.20		.48		.23

TABLE 10

Final questionnaire summary data

Item No.	Total		A Squadron			B Squadron			1 Armoured		
	Mean	S.D.	Mean	S.D.	Rank	Mean	S.D.	Rank	Mean	S.D.	Rank
1	3.87	3.27	3.85	3.18	1	3.77	3.34	1	4.13	3.58	2
4	4.89	3.05	5.13	3.02	3	4.37	3.14	2	5.33	2.97	5
10	4.91	3.24	4.63	3.09	2	5.46	3.05	3	4.47	4.07	3
8	5.59	3.45	5.20	3.15	4	7.37	3.35	10	2.67	1.99	1
3	6.31	2.97	5.41	2.71	5	7.06	3.12	8	7.33	2.72	7
9	6.44	3.36	6.72	3.49	8	6.66	3.51	6	5.07	2.31	4
5	6.90	3.16	6.44	3.12	6	6.51	2.94	5	9.20	2.91	11
11	7.14	2.89	6.59	2.99	7	7.74	2.47	11	7.40	3.36	8
12	7.19	3.22	7.54	3.14	9	6.49	3.57	4	7.73	2.40	9
7	7.50	3.27	7.96	3.11	11	7.20	3.39	9	6.80	3.51	6
2	7.98	3.40	7.70	3.61	10	8.34	3.62	12	8.00	2.07	10
6	8.14	3.23	8.89	3.08	12	6.63	3.32	7	9.33	2.09	12

TABLE 11

Inter-item correlation coefficients for final questionnaire (N = 97). Values underlined are those estimated to be significant at the 0.05 level (see text). Items 2,4,6,7 and 12 are "shine" items

Item No.	1	2	3	4	5	6	7	8	9	10	11	12
1		-.12	-.05	-.28	.02	-.22	-.19	.18	.05	-.11	-.02	-.13
2			-.06	.23	-.04	.04	-.02	-.07	-.04	-.03	-.17	-.08
3				-.07	.01	.02	-.20	-.06	.12	-.06	.02	-.14
4					-.11	.25	.11	-.26	-.12	-.05	-.13	.06
5						-.02	.06	-.22	-.04	-.07	.03	-.14
6							.12	-.40	-.05	-.15	-.19	.01
7								-.14	-.33	-.06	.04	.15
8									.13	-.07	.16	-.11
9										-.14	-.12	-.20
10											-.10	-.02
11												.06
12												

TABLE 12

Oblique factor pattern matrix from final questionnaire

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
1	-.39	-.07	-.19	.06	-.01
2	.02	.08	.05	.03	.45
3	.15	-.38	-.01	.00	-.14
4	.37	.14	.21	.07	.33
5	.04	.09	-.52	.03	-.03
6	.58	-.06	-.03	.17	.09
7	.16	.35	-.07	.10	-.08
8	-.67	-.03	.32	.13	-.05
9	-.08	-.53	.06	.14	.09
10	-.03	.03	.04	-.64	.03
11	-.13	.12	.05	.11	-.38
12	.14	.23	.19	-.02	-.20

TABLE 13

Communality of items on the final questionnaire

Item No.	Brief Description	Communality
1	Bulk	.216
2	Tape shine	.215
3	Mounted guns	.154
4	Glass shine	.376
5	Ground shadow	.273
6	Personnel equipment shine	.380
7	Turret shine	.362
8	Wheel shape	.566
9	Aerials	.334
10	Overall colour difference	.416
11	Vehicle shadow	.208
12	Other shine	.174

TABLE 14

Correlations between rotated factors

Factor	1	2	3	4	5
1	1.000	.178	.036	- .004	.140
2		1.000	.168	- .044	- .058
3			1.000	- .018	.046
4				1.000	- .013
5					1.000

APPENDIX 1

INITIAL QUESTIONNAIRE FOR ASSESSING EXPECTATIONS

PSYCHOLOGY OF DETECTION

1. Regt. No............................ Rank ....

   Name & Initials ....

2. Age ....

3. How long have you been in this unit? .... years ....mths

4. Have you previously had field experience looking for:

   a. M113s Yes/No

   b. Any other type of military vehicle Yes/No

   If 'Yes' state type ....

   ....

5. Which of the following best describes the amount of army training you have had in camouflaged object detection?

   a. none

   b. a few hours

   c. a few days

   d. a few weeks

   e. a few months

INSTRUCTIONS

There are three basic situations under which you will detect enemy vehicles:

		Letter Symbol
a.	stationary, without a camouflage net;	N
b.	stationary, with a camouflage net; and	C
c.	moving (no net)	M

As well as these three situations, the weather may be sunny, overcast, or wet. It looks as though our weather is going to be generally ...., so I would like you to answer the following questions on this basis.

The following is a list of factors, that is, cues, signals or guides that might aid you in the detection of an M113 APC.

What we want you to do is indicate to us how useful these cues are in the detection of an M113 APC in the three different situations indicated above, i.e., stationary without a cam net, stationary with a cam net, or moving.

You are to place the relevant letter symbol in the box which corresponds most with how useful you expect that cue to be in your aid to detection.

What we are interested in is what you actually expect - the normal situation. For example, suppose that over a few days I expect to make about 20 sightings of stationary M113 APC's without camouflage net covering. I also expect that if any vehicle is glossy this would probably be what makes me see it. However I don't expect more than 1 out of those 20 vehicles to give glossy reflections. So my position is:

a. if glossiness is there it probably causes detection;
b. it is not likely to be there;

and so I expect glossy reflections to be of little use in the real situation. I would then mark my answer like this:-

	No Use	Little Use	Moderately Useful	Very Useful	Extremely Useful
1. Glossy reflections from the vehicle		N			

On the other hand, you may consider that a glossy reflection is no use in the detection of a stationary M113 with a camouflage net or when the M113 is moving. So for Question 1 your final answer could look like this:

	No Use	Little Use	Moderately Useful	Very Useful	Extremely Useful
1. Glossy reflections from the vehicle	C,M	N			

Are there any questions?

N = Stationary, without a camouflage net
C = Stationary, with a camouflage net
M = Moving (no net)

	No Use	Little Use	Moderately Useful	Very Useful	Extremely Useful
1. Glossy reflections from vehicle					
2. General colour difference between vehicle and its surroundings					
3. Differences in patterning of vehicle and its surroundings					
4. Shape lines of the vehicle					
5. Edges of shadows of the vehicle					
6. Unusual shapes of shadows of the vehicle					
7. Aerial of the vehicle sticking up					
8. Movement of the aerial of the vehicle					
9. Movement of the vehicle					
10. Movement of the shadow of the vehicle					
11. Movement of bush around vehicle					
12. Movement of personnel around vehicle					
13. Dust cloud stirred up by the vehicle					
14. Are there any other features you expect to be useful? If so please explain what they are on the following page.					

APPENDIX 2

CONTACT REPORT FORM

These were printed on light cardboard of size 95 mm x 145 mm, consistent with the format used by 2 Cavalry Regiment. Only the additional sections associated with this trial are shown here.

TRIALS INFORMATION

F. Direction of target ______________________

G. Who observed the target? (circle response)

1. Crew commander
2. Driver
3. Gunner
4. Other (specify

____

H. Why was target observed? (circle response)

1. Shadow
2. Movement
3. Shine
4. Colour
5. Silhouette
6. Pattern
7. Size
8. Contrast
9. Shape
10. Fired upon
11. Other (specify)

____

I. Was vehicle camouflage painted? Yes/No ________________

J. Was target observed:

1. During initial scan, or
2. After detailed search, or
3. While moving.

APPENDIX 3

FINAL QUESTIONNAIRE FOR ASSESSING EXPECTATIONS

Note: The items have been numbered here: They were not numbered on the sheets given to subjects.

Suppose you were standing in a moderately open bit of local bushland looking for stationary enemy vehicles which you believe are 200-300 metres away. They pulled in there for a brief stop about 5-10 minutes ago. You are not using binoculars. Assume the enemy is fully tactical but does not have any pattern painting on his vehicle.

Order the following factors (that is cues, signals or guides) from 1 to 12 for probable usefulness in detection of the vehicle.

(1 = most useful, 12 least useful).

1. Bulkiness of shape around the bottom of trees __________
2. Shine from reflective tape on the vehicle __________
3. Mounted guns, missile launchers, etc. __________
4. Shine from glass surfaces on the vehicle __________
5. Shadow of the vehicle falling on the ground and surrounding foliage __________
6. Shine from clothing and equipment worn by personnel (e.g. badges, helmets) __________
7. Shine from non-glass parts of turret __________
8. Shape of wheels __________
9. Aerials on vehicles __________
10. Overall colour differences between the vehicle and its surroundings __________
11. Shadow of parts of a vehicle falling on that vehicle (e.g. wheel-arch shadows) __________
12. Shine from parts of vehicle other than glass, turret or tape __________

Not much information was sent back regarding trials data on the CONTACT REPORT form. Can you suggest to us some better ways of getting field information on why vehicles are detected?

What are the problems with the CONTACT REPORT form we provided?

APPENDIX 4

A BRIEF EXPLANATION OF FACTOR ANALYSIS

This statistical technique has its origins in the search for simplifying descriptions of complex data sets in which random variation is assumed. Early workers included Pearson (1901), Macdonnell (1902), and Thurstone (1931). The extensive calculations involved, however, restricted its usage until the provision of rapid computing facilities and software packages during the 1960's. It is now a technique used widely in the social sciences, particularly in the early stages of defining procedures and significant variables.

Suppose we wish to measure some complex aspect of behaviour. It is assumed that what we are measuring is multidimensional, and hence any single measure is represented by a point in hyperspace. This hyperspace may be described in terms of N dimensions, where N is generally unknown. Using factor analysis we attempt to determine n dimensions ($n \leq N$) which adequately represent that region of hyperspace which a set of measures or scales we are using measures in common. Factor analysis is most useful when, for most items, the common variance of each item is large compared to the remaining or unique variance of each item.

The basic equation of most factor analysis is

$$Z_j = \sum_{i=1}^{m} A_{ji} F_i + d_j U_j, \quad j = 1,2, \quad \ldots n$$

where Z_j is a measure on the j^{th} scale of the original scale set,

F_i $i=1,\ldots.m$ are the new factors, common to all scales,

U_j is a unique factor for scale j,

A_{ji}, d_j are regression weights.

U_j may be mainly measurement error, or it may be a genuine dimension not measured by any of the other items.

The initial stage of factor analysis is to determine factors, F_i, which maximise the variance in the original measures attributable to the F_i. The solution to this problem is not unique (Child, 1970) but a limited range of procedures is accepted. The final stage is to rotate the factors in hyperspace to obtain a simpler pattern of factor loadings.

The raw data for a factor analysis is the matrix of correlations between the various scales or items in the original test. The result of the analysis is a matrix of regression coefficients of the original scales on the factors determined. There are a number of different strategies which may be employed in determining factors. Consider the original scales and the derived factors as vectors in a hyperspace. The projection of a scale on a factor is a measure of the correlation between that scale/factor pair. A common requirement is that the factors be orthogonal to each other, though oblique (i.e. partially correlated) factors are psychologically more realistic. Another consideration is the definition of optimum structure used - one is that which is closest to having each scale load 1 on one factor and 0 on all others, while another is that having scales loading closest to 1 or 0 on each factor. Variations on these extremes are also used.

In the analysis used in this report, classical procedures of factoring were followed except that oblique rather than orthogonal factors were allowed on rotation.

References:

Pearson, K., 1901, "On lines and planes of closest fit to systems of points in space." *Philosophical Magazine*.

Macdonnell, W.R., 1902, "On criminal anthropometry and the identification of criminals." *Biometrika* 1, 177-227.

Thurstone, L., 1931, "Multiple factor analysis," *Psychological Review*, 38, 406-427.

Child, D., *The Essentials of Factor Analysis*, Holt, Rinehart & Winston, London, 1970.

APPENDIX 5

A PRINCIPAL COMPONENTS FACTOR ANALYSIS OF THE FINAL QUESTIONNAIRE

Classical factor analysis extracts factors based on minimising the residual common variance. An alternative is principal components factor analysis which operates by minimising the residual total variance in a set of measures. So whereas classical factor analysis only provides information on the factors describing the shared basis of scores, principal components analysis determines factors based on the total scores.

Since the purpose of the present analysis was to search for a more compact representation of the psychological space underlying expectations it is appropriate to examine both the common and the total basis. In interpreting the results of this particular analysis consideration has also been given to the mean ranking given to the items which weight the various factors. Table A5-1 gives the rotated factor matrix, with a brief descriptor of each item. Table A5-2 presents a reduced table with only the six most highly ranked items appearing (in descending order of expected value - see table 10) and only weights greater than 0.25 shown to facilitate interpretation. This analysis isolates two clear factors - factor 2 which can be described as a protruding lines factor, and factor 5 which is clearly a colour factor. Factors 1 and 4 show similar patterns of weightings except for wheel shape where the sign reverses. Factor 1 may be a factor combining the specific major features (size and tracks) of an M113 whereas factor 4 is a more general factor of bulk/not shine.

A comparison of tables 10 and A5-1 indicates that factors 1 and 2 in both cases are similar, and that factors 3 and 5 in table 10 correspond to factors 4, 5 and 3 (with sign reversed) respectively of table A5-2.

T A B L E A5-1

VARIMAX-ROTATED FACTOR PATTERN MATRIX FROM PRINCIPAL COMPONENTS ANALYSIS OF FINAL QUESTIONNAIRE

Variable Descriptor	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Bulk	- 0.59	- 0.10	- 0.04	- 0.33	0.14
Tape shine	0.05	0.03	- 0.71	0.09	0.08
Guns etc.	0.31	- 0.60	0.39	- 0.02	- 0.04
Glass shine	0.49	0.16	- 0.42	0.29	0.11
Ground shadow	0.08	0.12	0.11	- 0.83	0.04
Clothing shine	0.70	- 0.00	- 0.14	- 0.07	0.24
Non-glass turret shine	0.20	0.70	0.05	- 0.06	0.14
Shape of wheels	- 0.72	- 0.12	0.07	0.34	0.15
Aerials	- 0.10	- 0.69	- 0.09	0.03	0.22
Colour	- 0.03	0.04	- 0.04	0.05	- 0.95
Internal shadows	- 0.17	0.20	0.62	0.14	0.22
Other shine	0.15	0.42	0.26	0.43	- 0.01

T A B L E A5-2

SIMPLIFIED PRINCIPAL COMPONENTS FACTOR PATTERN MATRIX

Variable Descriptor	Mean Rank	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Bulk	3.87	- .59			- .33	
Glass shine	4.89	.49		- .42	.29	
Colour	4.91					- .95
Wheel shape	5.59	- .72			.34	
Guns	6.31	.31	- .61	.39		
Aerials	6.44		- .69			

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