TECHNICAL REPORT 4137

FIELD DEPENDENCE AND VISUAL DETECTION ABILITY

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DOVER, NEW JERSEY

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by

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ABSTRACT

The perceptual style known as field independence has been defined by various investigators as the ability to perceptually separate an object from within a complex background. This investigation attempts to test this concept in a literal manner by examining the relationship between several established measures of field independence and performance on a real-life visual detection problem.

Only one of the instruments used, the Hidden Figures Test, correlated significantly with performance. An added finding was a correlation between performance and general intelligence. Furthermore, interest correlations showed that the instruments used could be divided into two groups, each measuring what appears to be a separate quality of the field independence concept.

INTRODUCTION

The real life activity of searching for an object, such as a key dropped in the grass, is a more complex process than is readily apparent. This search process involves not only physical capabilities such as visual acuity, or sensation, but the psychological phenomena of cognition and perception as well. Thus, an individual's ability to detect objects in his visual field is put to a severe test when he is searching for concealed or camouflaged items.

The practice of camouflaging items to prevent them from being found may involve concealment by hiding or covering the object, or by altering its physical characteristics so that it blends into its background. When many camouflaged items are placed into a small area, however, it is possible to camouflage some of them by making others so distracting (easily found) that the "camouflaged" items are overlooked. Camouflage by blending and distraction forms the focus of this study.

The ability to detect a concealed but uncovered item requires that the individual overcome several problems best understood in the Gestalt concept of "figure-ground" relationships. The figure is partially concealed or camouflaged, while the ground consists of the earth, and the grass, leaves, and sticks that litter it.

The ability to visually separate a simple item or pattern from within a more complex pattern is said to be a primary indicator of an individual's style of perceiving (Witkin, Dyk, Paterson, Goodenough, and Karp, 1962). This ability has been studied under the name of field independence-field dependence. The purpose of this study is to examine the relationship between established measures of field independence and actual performance in detecting camouflaged objects.

LITERATURE REVIEW

Detection Theory

A number of recent studies by Strauss and his associates (Strauss, Carlock, Bucklin, and Rayner, 1968a, 1968b, 1968c) have demonstrated the need for a deeper understanding of the perceptual stage of visual detection. In attempting to evaluate several small military devices (less than 3 inches in any dimension) in terms of their inherent ability to go undetected, they found that differences between items were strongly diluted by vast individual differences among the subjects (Ss). It is well known that different levels of motivation produce different levels of performance on any task (Ammons, 1954). However, this does not account for the wide variation among motivated Ss who had normal vision (i.e., color, acuity), and who were thoroughly familiar with their target.

In order to be "detected," an object must first be at or above the visual threshold. This is the "sensation" stage of detection. The object itself must be successfully registered as a signal on the retina of the eye. Furthermore, this signal must be of sufficient strength to be transferred to the brain.

When the signal reaches the brain, the "sensation" stage is complete and the "perception" stage begins. There is a very real difference between these stages. The sensation stage is a purely physiological process and except for differences in physical makeup is relatively constant from person to person.

The perceptual stage, however, is cognitive. An image is meaningless until it is recognized, identified, and interpreted. A person's actions are not based on his sensations, but on perception of his sensations. Moreover, a perception is "not a high fidelity reproduction of stimuli impinging on the receptors, but is reproduction of the objects which these stimuli suggest" (Hilgard, 1948, p. 332). This perceptual reproduction, or more appropriately restructuring, requires the participation of many cognitive factors (Elliott, 1961; Newbigging, 1954). The perception is restructured in a fashion determined by all of our previous experiences as well as by our current desires and expectations. Family experience and genetic composition are both major contributors to the mode in which an individual restructures his perceptions (Braly, 1933; and Witkin, 1965). The characteristic way in which an individual perceives is called his perceptual style. Perceptual style, being a cognitive function, is a stable aspect of each individual's personality (Witkin, 1949, 1965; Witkin, Goodenough, and Karp, 1967).

Thus detection process involves first the sensation, then the correct perception of the item being searched for. It would be quite a simple matter to study detection only in terms of visual capability. However, even with the fundamental requirements for vision (Cobb and Moss, 1928) fulfilled, a great range of individual differences still exists. Moreover, visual characteristics do not determine an individual's characteristic way of perceiving (Barrett, Cabe, and Thornton, 1967, 1968). Therefore, it is the perceptual style of the individual, not his visual capacity, which we must examine if we hope to gain insight into the dynamics of detection.

It should be pointed out that camouflage is nothing more than superimposed organization (Hilgard and Atkinson, 1967). It is an attempt to conceal something by incorporating it into a dominant pattern that destroys the original configuration. Finding the item, then, must start from this point. Relevant lines (simple figure contours) of the complex figure must be perceived in "different relationships to one another from those that apply when the complex figure is perceived as such" (Newbigging, 1954, p. 204). The perceptual field must be restructured in subjective terms.

In relation to simple figures hidden in a more complex figure, the figure-ground relationship is unstable (Hebb, 1949). There are intervals between seeing the complex figure as a whole when the eye wanders and notices the contours; corners, curves, or straight edges. These contours are the stimuli which enable one to isolate the simple figure. In order to create a stable organization, one figure (the complex figure) may be destroyed perceptually (Hilgard and Atkinson, 1967). .

This concept of one figure hidden within a more complex one has been called embeddedness (Gardner, Holzman, Klein, Linton, and Spence, 1959; Jackson, 1956; Karp, 1963; Witkin, 1950; Witkin, Lewis, Hertzman, Machover, Meissner, and Wapner, 1954; Witkin et al, 1962). Embedding obscures the item by changing its nature. The original figure or its parts are organized into "new, competing gestalts" which break up the original figure (Karp, 1963). There has been some disagreement in the literature as to the meaning of embeddedness and distraction. Distraction, however, obscures without changing the nature of the item. The original properties remain intact. The abilities to overcome embeddedness and distraction are highly correlated even though there is some factorial difference (Karp, 1963). Both factors are relevant when studying camouflage.

Evidence of interest in perception of "concealed items" can be found at least 40 years ago (Wever, 1928). The area has been studied in earnest for about 20 years under the leadership of H.A. Witkin (1949). He and his colleagues have published two major books on the subject of perceptual style (Witkin et al, 1954; Witkin et al, 1962). His work has been heavily criticized, but primarily in the area of statistical procedures and his association of perception with personality (Gruen, 1957; Holtzman, 1955; Korchin, 1963; Proshansky, 1963; Zigler, 1963). There is little doubt, however, that his work with the concept of field independence-field dependence has opened the door for a great deal of research including the study dealt with in this report.

'Field independence' is the name given to the sphere of qualities that characterize someone who is able to separate a simple figure from a more complex figure in which it is embedded. This applies to the entire life sphere, not just to perceptual style. Basically, it involves the ability to "articulate, or differentiate, complex stimulus fields" (Gardner, Jackson, and Messick, 1960). The term 'field articulation' has been offered as an alternative to the dependence motif. The reason for this alternative is that differences described are not found in the degree of dependence upon the external field but in the selectiveness of attention upon aspects of the external field (Gardner et al, 1960). The terms field independent and field dependent will serve, however, to label those who are better or worse at differentiating the external field.

The field independent person is characterized as being analytical (Boersma, Muir, Wilton, and Barkam, 1969; Witkin et al, 1962). He is concerned with the details of his environment. He characteristically breaks up organized perceptual fields. He can readily separate an item from its context (Goodenough and Karp, 1961; Witkin et al, 1962). He deals with his environment actively; acting instead of reacting. He is aware of his inner life and has control over his impulses and enjoys the associated low level of anxiety. He has a great deal of self-esteem with confidence in his body and in his adult body image (Bloomberg, 1963). This gives him a great deal of self orientation and originality in dealing with the world.

The field dependent person is characteristically opposite. His cognitive style is global (Witkin et al, 1962), with a general passivity in dealing with his environment. His interest in and his ability for analytical tasks are low. He has little ability for spacial reorganization and has difficulty separating an item from its context

(Goodenough and Karp, 1961). The field dependent person readily accepts the prevailing field or context with very little attempt at originality (Crutchfield, Woodworth, and Albrecht, 1958; Linton, 1955). Direction is sought from without with an accompanying dependency upon and orientation toward other people. He lacks self awareness and has poor control of his impulses with the accompanying fear of his sexual and aggressive impulses. This produces anxiety and ego weakness, and a primitive body image (Bloomberg, 1963).

The quality of field independence has been investigated in relation to a great number of other variables. The most prominent of these variables is intelligence. In general, the performance of field dependents tends to be poorer than that of field independents in standard tests of intelligence (Crutchfield et al, 1958; Elking, Koegler, and Go, 1963; Goodenough and Karp, 1961). The reason for this finding is that some of the same skills that are needed to achieve success in intelligence tests are used in tests of field dependence. Included in this category is the ability to work rapidly under pressure. Also, large portions of some IQ tests are preceptual tests which would help to further explain the high correlations of IQ test results with field independence.

In fact, the highest correlations occur between field independence and portions of IQ tests measuring perceptual concepts (Bieri, Bradburn, and Galinsky, 1958; Elliott, 1963; Goodenough and Karp, 1961; Karp, 1963; Messick and Fritzky, 1963). These subtests include WAIS and WISC object assembly, match problems, block design, picture completion, and the SCAT Quantitative tests. Table 1 presents an overview of the correlations obtained between the Embedded Figures Test and the Hidden Figures Test (measures of field independence), and other tests mentioned in the literature.

Various investigators have attempted to relate field dependence with personality characteristics and disorders (Elliott, 1961; Honigfeld and Spiegel, 1960; Jackson, 1958; Ogden, 1966; Young, 1959). Witkin believed that the Embedded Figures Test could provide a non-clinical measure of personality. This was on the basis of the vast number of characteristics he felt differentiated field dependents from field independents. Most investigators, however, found that field dependence measures did not index personality traits or motives (Alexander and Gudeman, 1965; Dana and Goocher, 1959; Gibeau, 1965; Honigfeld and Spiegel, 1960; Wertheim and Mednick, 1958). One trait that does appear to follow Witkin's characterization is that of independence and other-directedness on the part of field independent Ss (Iscoe and Carden, 1961; Karp, Witkin, and Goodenough, 1965; Sofer, 1961; Witkin, Karp, and Goodenough, 1959).

There appears to be a change in an individual's level of field dependence when he is subjected to conditions of stress (Hochman, 1967). All Ss became more field dependent, with Ss previously rated as field dependent affected most by sensory deprivation in studies by Cohen and Silverman (1963), and by Scott, Bexton, Heron, and Doane (1959). However, Jacobsen (1966) found that field independence was increased by one hour of sensory deprivation. Sensory overload, moreover, also had the affect of increasing field independence in all Ss (Oltman, 1964). When subjected to pain, field independents tend to focus on the pain and, accordingly, have more reaction to the pain (Sweeney and Fine, 1965).

In the performance of both a tactual and a visual vigilance task, field independent Ss were superior to field dependent Ss (Moses, 1967; Vaught and Ellinger, 1966). The superiority was greatest in the vigilance task when the task was a complex one. The difference disappeared as the task became simple.

Measurements of Perceptual Style

The principal test used to investigate the perceptual style known as field dependence, the Embedded Figures Test, was developed by H.A. Witkin from Gottschaldt's figures (Witkin, 1950). He also claimed that the Rod and Frame Test and the Tilting Room-Tilting Chair Test measured the same dimension (Witkin et al, 1954). There is evidence, however, to indicate that different qualities of perceptual style are measured by these tests (Gardner, 1961; Witkin et al, 1962).

The Embedded Figures Test (EFT) is generally accepted to be the most adequate of the measures of field dependence (Gardner et al, 1960; Gardner, 1961; Witkin et al, 1962). The EFT consists of eight simple figures and 24 complex figures (See Appendix A). The complex figures are made more complex by the addition of color patterns (Witkin, 1950).

The S is shown the complex figure for fifteen seconds.

Table 1

Correlations among Hidden Figures Test, Embedded Figures Test, and other measures (as compiled from literature)

With	Correlation	Source
	Embedded Figures Test	
Reversal	.24[a]	Haronian and Sugarman, 1966
	.47[b]	Newbigging, 1954
SCAT Quantitative	.29[a]	Elliott, 1961
	.39[b]	Spotts and Mackler, 1967
SCAT Linguistic	.21[a]	Elliott, 1961
Concealed Figures	.60[b]	Gardner, Jackson and Messick, 1960
WAIS	.48[b]	Haronian and Sugarman, 1966
Hidden Figures	.55[b]	Spotts and Mackler, 1967
Otis IQ	.34[a]	Spotts and Mackler, 1967
	Hidden Figures Test	
Color Word Test	.28[b]	Messick and Fritzky, 1963
WAIS	.48[b]	Haronian and Sugarman, 1966
		Gibeau, 1965
Otis	.42[b]	Spotts and Mackler, 1967
SCAT Quantitative	.31[a]	Spotts and Mackler, 1967
Speed of Direction Discrimination	.35	Messick and Fritzky, 1963

[a] = .05 level of significance
[b] = .01 level of significance

Then the complex figure is removed and the simple figure is shown for ten seconds. After this, the simple figure is removed and the S is shown the complex figure and asked to locate the simple figure within it. The time required to find the simple figure is recorded. If necessary, the simple figure could be seen again, for an additional ten seconds, with the complex figure removed. A five minute limit is imposed upon the search time.

Several variations of the EFT are available for research. Jackson (1956) found that he could use only twelve of the 24 complex figures while maintaining a correlation of .99 between the short form scores and the scores on the full test. However, this variation still must be administered individually. Wherever time is critical, it is desirable to have a test which may be group administered.

Two tests which are reported to measure field dependence and which can be administered to groups are (the Hidden Figures Test (HFT), and the Hidden Patterns Test (HPT). They are found in the _Kit of Reference Tests for Cognitive Factors_ developed by French, Ekstrom, and Price (1963). The kit is a battery of 74 tests covering 24 aptitude and achievement factors compiled by the authors. The HFT and the HPT are found in the first factor which is called 'Flexibility of Closure.' The factor was isolated as "the ability to keep one or more definite configurations in mind so as to make identification possible in spite of perceptual distractions" (French et al, 1963, p. 9). These tests require the S to find a simple figure which is embedded in a field of "irrelevant or distracting material" (French et al, 1963, p. 9). This factor is said to relate to Witkin's dimension of field dependence (French et al, 1963; Messick and Fritzky, 1963).

The first test, the HFT, is an adaptation of the same Gottschaldt figures as were used by Witkin. This test is relatively difficult but is rated for grades 6 through 16. In comparisons with Witkin's individually administered EFT, the HFT correlated at the .01 level of significance (Jackson, Messick, and Myers, 1964; Moses, 1967; Spotts and Mackler, 1967). It was found that the lack of color could be compensated for by increasing the level of difficulty of the complex figures. Furthermore, the HFT eleminates the memory factor found in the EFT. The lack of a memory component appears to emphasize the ability to resist embeddedness (Jackson et al, 1964).

The HFT consists of two parts which are structurally the same. Each part has two pages and the S has ten minutes to work on each part. At the top of each page are five simple figures. The same five figures are used in both parts of the test. The simple figures are identified with the letters A through E. Each part contains sixteen complex figures and the task is to determine which of the simple figures appears in each of the complex figures (see appendix). The score is the total number marked correctly minus ¼ of the number marked incorrectly to correct for guessing.

The second test from the closure flexibility factor is the HPT. This test is an adaptation of Thurstone's Designs (French et al, 1963) which is itself a variation of the Gottschaldt figures. The items in this test are easier than those in the HFT but are given under very high speed conditions. This test is also suitable for grades six through sixteen.

The HPT consists of two parts, each containing 200 complex patterns. One simple pattern is displayed at the top of each page and the S has two minutes to identify the complex figures that contain the simple pattern. The same simple pattern is used and the procedure is the same for the second half. The score is the total number correctly marked minus the number marked incorrectly to correct for guessing.

A third test which appears to measure a similar, if not the same dimension is the Concealed Figures Test (CFT). The CFT is also an adaptation of Gottschaldts figures (Thurstone and Jeffrey, 1965); it has been used to measure the same quality as the EFT (Elliott, 1963; Ogden, 1966; Thurstone and Jeffrey, 1965). This test measures the "capacity to see a given configuration (diagram, drawing, or figure which is 'hidden' or embedded in a larger, more complex drawing, diagram, or figure" (Thurstone & Jeffrey, 1965, p. 1).

The content of the CFT is similar to that of the HFT. It consists of 49 simple figures, each of which is accompanied by four complex patterns. Each complex pattern must be classified as containing or not containing the simple figure it accompanies. The S has ten minutes to complete as many of the items as he can. The score is the number right minus the number wrong to correct for guessing.

A different kind of test can be used to measure field dependence. The Stroop Color Word Test (CWT) is not as much a test of embeddedness as it is a test of interference

(Stroop, 1935, 1938). However, the same adaptive requirements that are necessary for high performance on Witkin's EFT are needed for the CWT (Gardner et al, 1959). As such, the CWT is considered to be a valid measure of field dependence (Bloomberg, 1965; Gardner et al, 1959; Gardner et al, 1960; Messick and Fritzky, 1963). This is true even though it may not be measuring exactly the same dimension as the tests already discussed. In a factor analytic study of several measures of field dependence, Gardner, Jackson, and Messick (1960) found that the CWT is not contained in the same factor as the CFT and the EFT.

The Speed of Color Discrimination Test (SCD) is an adaptation of Stroop's 1935 CWT, developed by Samuel Messick of the Educational Testing Service in 1964. Another version of the original (1935) Stroop test has been develcped by Thurstone (1944). The Messick version consists of two parts: the first part being patches of four different colors: red, blue, green, and orange. The S has to print the first letter of the name of the color of the patch under each patch. The test is highly speeded and the S works 45 seconds on each of four pages.

The second part consists of the printed names of the same four colors, each printed in different colors. For example, the word red may appear in red, blue, green or orange colored ink. The S must print under each word the first letter of the color in which the word is printed. This part is again highly speeded and the S works 45 seconds on each of four pages. This is the interference condition. Scoring is the number completed correctly on the second part.

In the SCD test, the tendency is to respond to the meaning of the word rather than to the name of the color in which it is presented. This tendency is very compelling and varies with individuals (Gardner et al, 1960). Field independent Ss should be able to direct their attention to the color and resist distraction by the meaning of the word (Gardner et al, 1959). This is one way of overcoming embeddedness.

The Speed of Direction Discrimination Test (SDD), obtained from the Educational Testing Service in Princeton, New Jersey, is similar to the SCD test, and has also been used in field dependence studies (Messick and Fritzky, 1963). The first part consists of the word 'round' printed in four different directions; vertically from top to bottom (down), vertically from bottom to top (up), horizontally from left to right (right), and horizontally from right to left (left). The S is required to print the first letter of the word indicating the direction in which the word 'round' is printed. He must print the proper letter under as many words as he can in 45 seconds. He repeats this procedure on four successive pages.

The second part consists of the words 'up', 'down', 'right', and 'left' printed in the same four directions as are used in the first part. The object is to print the first letter of the word meaning the direction of printing and disregard the meaning of the printed word. For example, the word 'down' may be printed horizontally from left to right. The correct response would be 'R' for right---not 'D' for down. As in the SCD test, the tendency is to respond to the meaning of the printed word. This tendency is increased by the mental set developed during the first part. The second part also contains four pages with 45 seconds allotted to each page. The test is highly speeded. Scoring is the same as the SCD test.

Several reversible illusions have been used to study field dependence (Bloomberg, 1965; Haronian and Sugarman, 1966; Jackson, 1958; Newbigging, 1954). The best example of this is the work of Haronian and Sugarman (1966) with the Necker Cube. When you look steadily at the Necker Cube, it appears to change orientation. The ability to actively control the rate of reversal, either to slow it down or speed it up, was shown to be related to field dependence (Haronian and Sugarman, 1966; Newbigging, 1954). This relationship only holds true under active instructions to try to control the reversals. Under passive instructions (just counting reversals), there is no difference between field dependents and field independents. This confirms the results of Newbigging (1954).

Two experimental tests from Educational Testing Service are very similar to the SDD test described above. There are the Speed of Number Summation (SNS) and the Speed of Form Discrimination (SFD). Both of these tests are conducted under highly speeded conditions to develop mental set and then introduce a speeded interference condition. In the SNS test, the first part involves adding two sets of tallies (ones) joined by a plus sign. The second part consists of adding the number of letters of two names of numbers (for example, four and seven), joined by a plus sign.

The first part of the SFD test involves identifying three types of print; capitals, non-capitals, and italics. The second part consists of identifying the kind of type used in printing the words 'capitals', 'non-capitals', and 'italics', each of which is printed in the various kinds of type (see appendix for examples).

The Hidden Figures Test -V contains the same simple and complicated figures as the HFT already described. However, in the V version, memory is used as in the EFT by printing one simple figure and one complicated figure on opposite sides of a page. This means that the S cannot see both figures at the same time.

In summary, the concept of field dependence- independence has been shown to be relevant to the problem of detecting objects in a complex "live" background situation. Further, many well-researched measures of field dependence are available. It should be possible then, to relate these measures to subject performance in a realistic (rather than laboratory) task.

SCOPE AND PURPOSE OF THIS STUDY

There is a large group of military devices which are mass-emplaced and function best when undetected. It is required that we become familiar with the qualities of human detection ability for the purposes of designing our own systems and also counteracting similar systems developed by hostile forces. What makes one man an able detector while another man is less adept at this task? It would be a savings of both time and money if men could be rated for their detection ability without a preliminary field test.

The men who are rated as "good detectors" could then be used in field tests to evaluate new or novel items. The vast individual differences which diluted the item differences in the tests of Strauss and his associates (Strauss et al, 1968a, 1968b, 1968c) could be eliminated and a more realistic evaluation of item configuration could be obtained.

Once "good detectors" are identified, they can be studied further to try to determine what characteristics may be common to this group. If there is some common training experience, we may be able to teach other men to be good detectors.

This evaluation of tests of field dependence as predictors of detection performance took place as a separate part of a larger test program in which three small military devices (to be described later) were compared. Inasmuch as the items were "tactical" in nature, enlisted military personnel were used as Ss for the test. Furthermore, because of the more complex terrain backgrounds found in tropical climates (jungles), it was felt that this geographical and climatic region offered a "worst case" test of search and detection ability. The site of the larger test was the Panama CanalZone. This area has both a typical tropical environment and the material and personnel support required by field tests of the type conducted.

The pros and cons of conducting a field test as opposed to a laboratory study were carefully considered. In a field test, the visual field is always (realistically) changing. The chance of any item appearing in the same background twice is extremely small. Furthermore, Ss must attend to the entire visual field. In the field, Ss must watch where they are walking and be alert to overhead obstructions. In the jungle especially, one must be constantly alert to many hazards. In a laboratory, the area in which the stimulus is presented is all that must be observed. Having to maintain vigilance for more than just the target increases the realism and the difficulty of the task. As has already been noted, field independence is of more benefit in a complex visual task than a simple one.

The primary disadvantage of a field study is the matter of control. In the jungle, no two trails are exactly alike. Some may contain more ground litter or be flatter and therefore easier to walk along. Others may be of a different color or contain more physical hazards. Furthermore, when such things as changes in light are added, there is a considerable amount of variability which must be controlled or balanced.

A second disadvantage is that field testing usually requires much more time and considerably more support and expense. Such things as weather and darkness can terminate an otherwise successful testing period. It was felt, however, that the advantages far outweighed the disadvantages.

The relationship between field dependence and the ability to detect concealed or embedded objects in a field situation is the subject of this study. The primary hypothesis is that those Ss who score high in certain measures of field independence will find more camouflaged objects than those who are field dependent (i.e., who score low in the tests).

A secondary hypothesis, which will be examined, is that not all tests which are said to measure field dependence are measuring the same quality. The implication of this is that the perceptual style called field dependence is an obscure concept which needs to be further defined and analyzed.

METHODOLOGY

Test Subjects

Fifty Ss were randomly selected from the population of enlisted army personnel stationed in the Panama Canal Zone at the time of the test. The validity of considering the sample group representative of all U.S. Army personnel was borne out in results to be described later. Nine Ss were eliminated because they did not complete some aspect of the testing, reducing the final total of Ss to 41.

Instruments Used

From the list of tests previously described, the Hidden Figures Test (HFT), the Hidden Patterns Test (HPT), The Concealed Figures Test (CFT), the Speed of Color Discrimination Test (SCD), and the Speed of Direction Discrimination Test (SDD) were selected for use on the basis of: (1) ease of group administration (this was necessary because there was not time for individual administration); (2) variation of task; (3) simplicity of instructions (even though all instructions were read aloud by the examiner, this helped eliminate the loss of data due to failure to follow instructions). An additional test was used even though it was not administered as part of this investigation. The Army General Classification Test (AGCT) is administered to all U.S. Army enlisted personnel, and each man's score is kept in his career file.

The AGCT contains vocabulary, arithmetic reasoning, and block counting items. Measures are obtained in the areas of verbal, numerical, and spatial content (Anastasi, 1961). Both percentiles and standard scores are available for the AGCT, with the latter adjusted to yield a mean of 100 with a standard deviation of twenty. This test has been validated in studies involving test achievement compared to later performance as well as by correlation with other measures of intelligence (Anastasi, 1961). This measure of general intelligence was considered desirable for two reasons: First as has been explained, the relationship between field dependence and intelligence is not too clear. This means that further data may add to the knowledge about this phenomenon.

The second reason for using this test was to validate the sample used. The scores obtained by the men in our sample can be compared with the standard scores obtained from the population. In this way, we can establish the "normality" of our sample.

Target Items

The three target items used differed widely in construction: the TW item was a 2¼ inch sphere; the AD item was a cylinder 1¼ inches in diameter and 1¼ inches in height. Both the TW and AD items were made of olive drab painted metal. The P device was a flat, olive drab, cloth bag, 3/4 of an inch square. The items also differed in their mode of activation. The TW device displayed tripwires all around itself. The AD device was activated by any movement of the item. The P device was activated by being stepped on.

Procedure

To obtain detection performance measures, the Ss were tested by means of an actual field problem. The test area was a semi-deciduous jungle in the Panama Canal Zone. The terrain was quite rugged. Through this jungle, seven trails, approximately one to two meters wide and 750 meters long were constructed. Each trail was divided into three 250-meter sections. The three types of items were distributed within these trails according to a Greco-Latin Square model (Table 2). The items were randomly placed and both density and types of items were varied for each trail and each day. Table 3 shows a typical density/item pattern.

The Ss were divided into groups of 3 with 2 groups assigned to each of the 7 trails. Noncommissioned officers (NCO's) served as observers and accompanied the men on their trail, one group at a time. Each man in the team searched for ten minutes and then rotated with another team member until his turn came again. Thus, each man had the opportunity to search for different items on different sections of the trail. Each team covered the length of their trail once each day for seven days.

The object of each run was to visually detect as many of the items as possible without disturbing them. Motivation to perform well was increased in most Ss by fostering competition both within and between groups. The NCO observer recorded how many and which type of item each man found. The performance score used was the percentage of items detected (number detected/number emplaced).

TABLE 2

Greco-Latin Square Design

Trail	Days						
	1	2	3	4	5	6	7
1	1A	2B	3C	4D	5E	6F	7G
2	2C	3D	4E	5F	6G	7A	1B
3	3E	4F	5G	6A	7B	1C	2D
4	4G	5A	6B	7C	1D	2E	3F
5	5B	6C	7D	1E	2F	3G	4A
6	6D	7E	1F	2G	3A	4B	5C
7	7F	1G	2A	3B	4C	5D	6E

Item Types	Item Positions
1 - TW	A - 111 (Items distributed in all sections)
2 - AD/P	B - 102 (Items distributed in section one in normal density. Section two was empty and section three contained twice the normal density of items.
2 - AD	C - 120
4 - TW/P	D - 201
5 - TW/AD/P	E - 210
6 - P	F - 012
7 - TW/AD	G - 021

TABLE 3

Typical Density/Item Distribution

Day 4		Trail 4		
(3)	TW TW TW	(6)	AD AD AD AD AD AD	250 Meters
(6)	TW TW TW TW TW TW	(12)	AD AD AD AD AD AD AD AD AD AD AD AD	250 Meters
0	(TW)	0	(AD)	250 Meters

Note: Items randomly placed in each section.

RESULTS AND DISCUSSION

The hypothesis that Ss shown by appropriate tests to be field independent would be superior detectors was tested by examining the correlation between test scores and field performance. A correlation matrix was constructed which included each of the tests used, the total score obtained on the test battery, and the performance score.

As can be seen in Table 4, the highest correlation of a test with performance was obtained with the HFT. The Pearson r of .36 is significant at the .01 level. The only other score which correlated significantly with performance was the AGCT. The r of .26 is significant at the .05 level. A multiple correlation of performance with the HFT and the AGCT only increased the correlation to .37.

The HFT also correlated more closely with the AGCT than did any of the other tests. The intercorrelation of these three variables indicates a probably connection between detection ability (as measured by the HFT) and general intelligence. The correlation between the AGCT and the HFT was significant beyond the .01 level.

The HFT was subjectively judged to be the most difficult of the tests given. It had the largest coefficient of variation (a list of variation coefficients is shown in Table 5) and, for this reason, was a better tool for discriminating among Ss according to ability.

Further examination of Table 4 shows that the secondary hypothesis, that not all of the tests would measure the same quality, is also upheld. The between-test correlations can be divided into two groups. These two groups overlap in the CFT. Group one contains the AGCT, the HFT, the HPT and the CFT. Group two contains the SDD, the SCD, and the CFT. The SDD test does correlate with the AGCT, possibly because of its verbal content.

That the CFT is the overlap point of the two groups is further illustrated by the high correlation between it and the entire test battery. Although all of the tests correlated with the entire battery score, the r of .84 for the CFT is outstanding. What is equally significant is the fact that none of the tests in group two (the CFT, the SDD test, and the SCD test) correlated significantly with detection performance.

TABLE 4

Correlation matrix for tests

	Performance	AGCT	HPT	HFT	CFT	SDD	SCD
AGCT	.26[a]	—	.29[a]	.46[b]	.32[a]	.44[b]	.20
HPT	.21	.29[a]	—	.56[b]	.64[b]	.13	.25
HFT	.36[b]	.46[b]	.56[b]	—	.56[b]	.24	.23
CFT	.14	.32[a]	.64[b]	.56[b]	—	.45[b]	.48[b]
SDD	.13	.44[b]	.13	.24	.45[b]	—	.62[b]
SCD	.22	.20	.25	.23	.48[b]	.62[b]	—
Total Battery	.30[a]	.59[b]	.62[b]	.74[b]	.84[b]	.66[b]	.65[b]

a = .05 level of significance
b = .01 level of significance

TABLE 5

Descriptive statistics obtained from test scores and field performance

	Performance[a]	AGCT	HPT	HFT	CFT	SDD	SCD
Mean	63.95	96.15	52.41	5.95	64.44	25.78	36.44
Standard Deviation	12.06	16.86	21.15	3.23	27.16	7.45	8.67
Coefficient of Variation	18.86	17.54	40.35	54.62	42.16	28.90	23.79

Note: N = 41

[a]Performance is measured by the percent of items detected

For the most part, the division of the tests into two groups is easy to explain. The HFT, the CFT, and the HPT all contain the same type of test items. These tests involve the perceptual separation of a simple figure or geometric form from a more complex form. In this way, all of these tests require from the Ss something of the same ability in order to score high.

In the correlations within the second group of tests, the SDD and the SCD would be expected to correlate with each other. Each of these tests requires the S to overcome the tendency to respond to a printed word and respond to other cues. The correlation that was not expected is that between both of the interference tests and the CFT. One difference between the CFT and the HFT and HPT may explain this.

In the HFT and the HPT, the S makes only positive responses. He decides which simple figure is contained in each complex figure in the HFT, and which complex figures contain the simple figure in the HPT. In the CFT each complex figure must be judged as containing or not containing the appropriate simple figure. This may introduce an interference condition in the CFT which produces the correlation with the SCD test and the SDD test. If this is the case, it would indicate that performance on the detection task does not involve an interference condition.

The reason that only the HFT correlated so successfully with performance is somewhat illusive. It may be that time was not a critical factor in either the detection task or the HFT. There was no time limit in the detection task and even though the HFT was timed, the amount of time allowed (ten minutes for each section) and the smaller number of items involved (sixteen complex figures) did not evoke the "hurry-up" facet of the other tests, both of which emphasized speed and the improbability of finishing.

The correlations between the tests of the first group (CFT, HFT, and HPT) and the AGCT support the relationship between field dependence and intelligence previously described. The AGCT contains one section that is primarily perceptual (Block Counting Items) and speed produces higher scores on the test. This similarity with the tests measuring field dependence would account for some correlation between the field dependence tests and the AGCT.

The assumption that the sample was representative of Army enlisted personnel in general was also validated. A 't'-test was computed between the scores of the Ss and the accepted theoretical Army wide score (Mean = 100, SD = 20). This test showed that a sample like this one could be drawn from the normal population more than 15 percent of the time.

CONCLUSIONS

The most evident conclusion is that the HFT is the best of the instruments used for estimating visual detection performance. This test should form the core of any further investigation of this relationship. The addition of a general intelligence test like the AGCT does not improve the value of the HFT as a selective instrument. It should be used wherever feasible, however, because it does correlate with detection performance by itself. It may also provide further information as to the general characteristics of a good detector.

Interference-type tests, such as the SDD, the SCD, and possibly the CFT, do not measure the ability necessary to be successful at a visual detection task. It is more likely that these tests measure the ability to work rapidly and carefully.

It appears that there may be more of a difference between distraction and embeddedness than is apparent in the literature. If the definitions given above are accepted, it would appear that the visual detection problem studied was a problem in embedding. The basis for this is the correlation between the detection performance and the HFT which is supposed to be an embedding problem.

The question that arises is whether or not distraction increases or even produces embedding. If an item is not seen, is it because it was embedded in the field or because a distracting item caused the S to direct his attention to part of the field which did not contain the other item?

Since there are at least two dimensions to the quality of field dependence (resistance to embeddedness and resistance to interference) tests accepted as measuring "field dependence" must recognize these elements. More work should be done to define the qualities of field dependence. It would also be advisable to reevaluate the distraction vs embeddedness problem.

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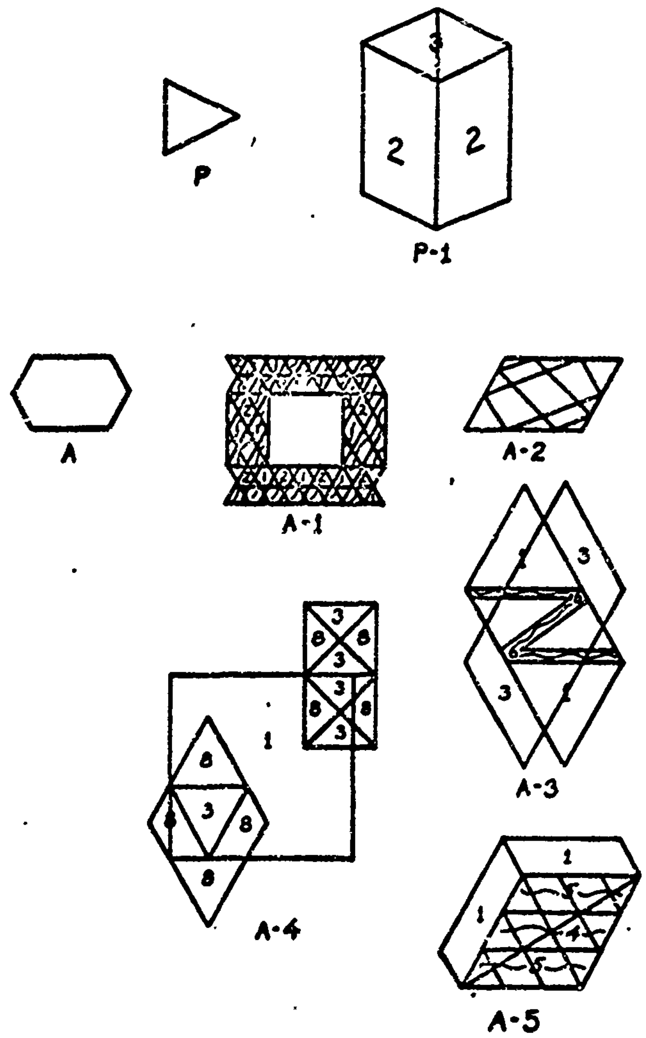
APPENDIX A

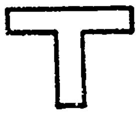
Embedded Figures Test

FIG. 1. SIMPLE AND COMPLEX FIGURES USED IN THE EMBEDDED-FIGURES TEST.

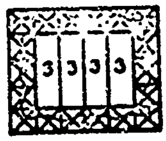
The simple figures are designated by a letter; the complex figures are designated by a letter and a number, the letter corresponding to that of the simple figure which it contains. Figures P and P-1 are the practice figures.

The specific colors used in each complex figure are represented by numbers; and wherever necessary the area covered by a given color is indicated by wavy lines radiating from the number. Figure A-2 remained uncolored. The colors to which the numbers refer are as follows: 1—red, 2—blue, 3—orange, 4—yellow, 5—brown, 6—dark green, 7—light green, 8—black.

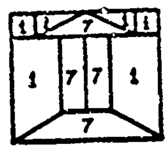




B



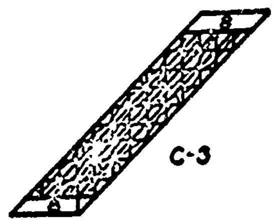
B-1



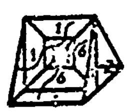
B-2

C

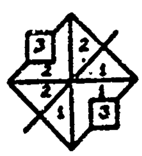
C-1



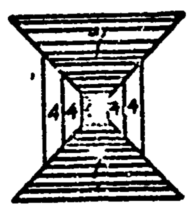
C-3



C-2

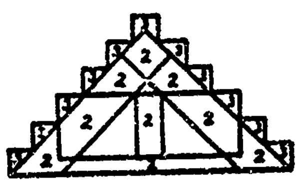


C-4

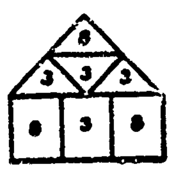


C-5

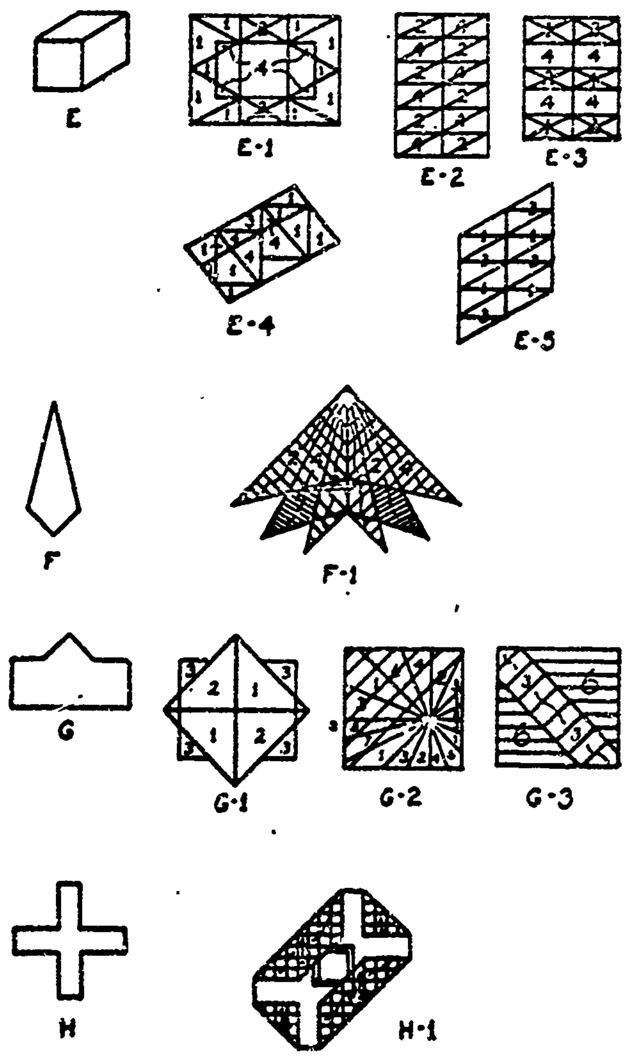
D



D-1



D-2


E
E-1
E-2
E-3
E-4
E-5
F
F-1
G
G-1
G-2
G-3
H
H-1

APPENDIX B

Hidden Figures Test

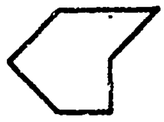
Name: ____________________

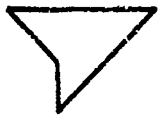
HIDDEN FIGURES TEST — Cf-1

This is a test of your ability to tell which one of five simple figures can be found in a more complex pattern. At the top of each page in this test are five simple figures lettered A, B, C, D, and E. Beneath each row of figures is a page of patterns. Each pattern has a row of letters beneath it. Indicate your answer by putting an X through the letter of the figure which you find in the pattern.

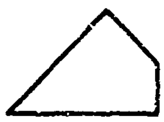
<u>NOTE</u>: There is only one of these figures in each pattern, and this figure will always be right side up and exactly the same size as one of the five lettered figures.

Now try these 2 examples.

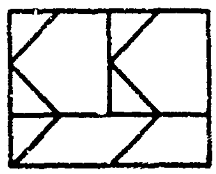

A

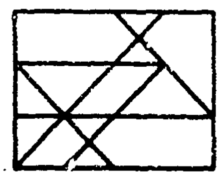

B


C

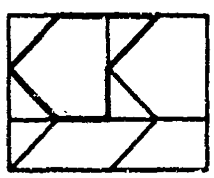

D

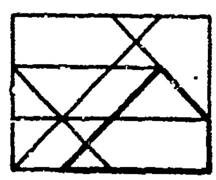

E

I 
A B C D E

II 
A B C D E

The figures below show how the figures are included in the problems. Figure A is in the first problem and figure D in the second.

I 
X B C D E

II 
A B C X E

Your score on this test will be the number marked correctly minus a fraction of the number marked incorrectly. Therefore, it will <u>not</u> be to your advantage to guess unless you are able to eliminate one or more of the answer choices as wrong.

You will have <u>10 minutes</u> for each of the two parts of this test. Each part has 2 pages. When you have finished Part 1, STOP. Please do not go on to Part 2 until you are asked to do so.

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

Developed under NIMH Contract M-4186

APPENDIX C

Concealed Figures Test

CLOSURE FLEXIBILITY

(Concealed Figures)

(Form A)

Please fill in:

Name ______________________

Age __________ Sex ______ Date ________

Occupation ______________________

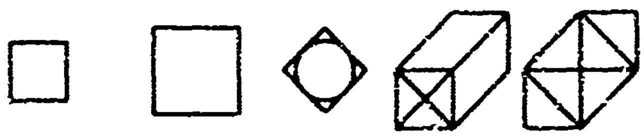
____

Developed by: L.L. Thurstone, Ph.D. and T.E. Jeffrey, Ph.D. - The Psychometric Laboratory - The University of North Carolina

Directions:

The row of designs below is a sample item of this test. The parts have been labeled to make description easier. These labels do not appear in the test items. The left hand design in each row is the figure. You are to decide whether or not the figure is concealed in each of the four drawings to the right. Put a check mark (✓) in the parentheses under a drawing, if it contains the figure. Put a zero (0) in the parentheses under a drawing, if it does not contain the figure. Look at the row of designs below.

Figure | Drawings 1 2 3 4

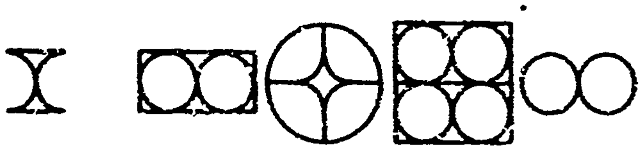


(0) (0) (✓) (✓)

In the row above a zero (0) has been written in the parentheses under drawing 1. The first drawing is a square but it is larger than the figure. A zero (0) has been written under drawing 2. Although the second drawing contains a square of exactly the same size as the figure, it has been turned. Check marks (✓) have been written under the third and fourth drawings since they each contain a square of exactly the same size as the figure and have not been turned. It does not matter that the figure contained in drawings three and four is on a different level from the figure at the left.

Sample:

Here is another example for practice. Try it.



( ) ( ) ( ) ( )

You should have placed check marks (✓) in the parentheses under the first and third drawings and zeros (0) in the parentheses under the second and fourth drawings.

WHEN YOU GET THE SIGNAL TO BEGIN, turn the page and mark more problems of the same kind. Work as fast and as accurately as you can, but do not guess. Wrong answers will count against you. You are not expected to finish in the time allowed. You will have exactly ten minutes to do as much as you can.

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APPENDIX D

Hidden Patterns Test

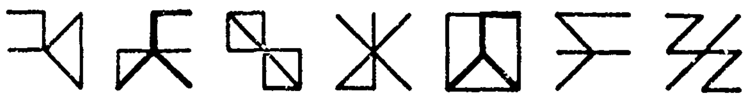
Name: ______________________________

HIDDEN PATTERNS TEST — Cf-2

How quickly can you recognize a figure that is hidden among other lines? This test contains many rows of patterns. In each pattern you are to look for the model shown below:

The model must always be in this position, not on its side or upside down.

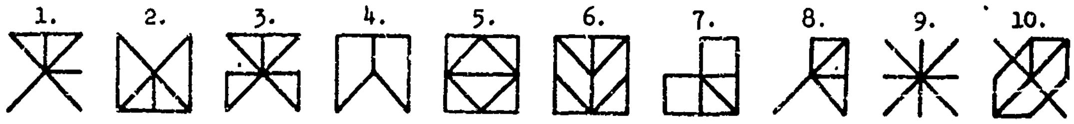
In the next row, when the model appears, it is shown by heavy lines:



( ) (X) ( ) ( ) (X) ( ) ( )

Your task will be to place an X in the space below each pattern in which the model appears. Now, try this row:

1. 2. 3. 4. 5. 6. 7. 8. 9. 10.



( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( )

You should have marked patterns 1, 3, 4, 8, and 10, because they contain the model.

Your score on this test will be the number marked correctly minus the number marked incorrectly. Work as quickly as you can without sacrificing accuracy.

You will have <u>2 minutes</u> for each of the two parts of this test. Each part has two pages. When you have finished Part 1, STOP. Please do not go on to Part 2 until you are asked to do so.

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

APPENDIX E

Speed of Direction Discrimination Test

SPEED OF DIRECTION DISCRIMINATION TEST

The following items consist of the word ROUND printed in four different directions: upward, downward, to the left, and to the right. For example:

		D		R		R	D
		N		O		O	N
DNUOR	ROUND	U	DNUOR	U	ROUND	U	U
		O		N		N	O
		R		D		D	R

You are to write under each item the first letter of the direction in which the word ROUND is printed. Print R if the word is spelled out in the usual way toward the Right, print L if it is spelled out toward the Left, U if it proceeds upward, and D if it proceeds downward. For example:

			R	D		
			O	N		
			U	U		
DNUOR	ROUND	DNUOR	N	O	ROUND	DNUOR
			D	R		
L	R	L	D	U	R	L

THE ITEMS MUST BE COMPLETED IN ORDER, beginning at the top of the page and working each row from left to right. Do not omit any items.

This test is highly speeded, so work as quickly as you can without making errors. There will be four separately timed parts. Wait for the signal before turning the page.

Remember, work as fast and as accurately as possible.

The following items consist of the words UP, DOWN, LEFT, AND RIGHT, each printed in four directions: upward, downward, to the left, and to the right. For example:

FOR EXAMPLE

		N			T		L
		W		U	F		E
THGIR	UP	O	THGIR	P	E	DOWN	F
		D			L		T

You are to write under each item the first letter of the direction in which the word is printed. Print R if the word is spelled out in the usual way toward the Right, print L if it is spelled out toward the Left, U if it proceeds upward, and D if it proceeds downward. For example:

		N			T		L
		W		U	F		E
THGIR	UP	O	THGIR	P	E	DOWN	F
		D			L		T
L	R	U	L	D	U	R	D

THE ITEMS MUST BE COMPLETED IN ORDER, beginning at the top of the page and working each row from left to right. Do not omit any items.

This test is highly speeded, so work as quickly as you can without making errors. There will be four separately timed parts. Wait for the signal before turning the page.

Remember, work as fast and as accurately as possible.

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO

APPENDIX F

Speed of Color Discrimination Test

SPEED OF COLOR DISCRIMINATION TEST

The following items consist of samples or patches of four different colors—red, blue, green, and orange. For example:

*****	*****	*****	*****	*****	*****
*****	*****	*****	*****	*****	*****

You are to print under each color the first letter of the color's name. Print R under each patch of *red*, B under each patch of *blue*, G under each patch of *green*, and O under each patch of *orange*. Here is how a set of items should look when completed.

*****	*****	*****	*****	*****	*****
B	G	O	B	G	O
*****	*****	*****	*****	*****	*****
R	O	G	R	B	R

THE ITEMS MUST BE COMPLETED IN ORDER beginning at the top of the page and working each row from left to right. Do not omit any items.

This test is highly speeded, so work as quickly as you can without making errors. There will be four separately timed parts. Wait for the signal before turning the page. Remember, work as fast and as accurately as possible.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

The following items consist of the *names* of four colors printed in different colored inks. For example, the name "orange" may be printed in either blue, red, green, or orange ink. Here are some sample items:

orange red blue orange green orange blue green

green green blue green orange green red blue

You are to print under each word the first letter of the *color in which the word is printed.* Print R under a word printed in Red ink, B under a word printed in Blue ink, G under a word printed in Green ink, and O under a word printed in Orange ink. Ignore the meaning of the words themselves and indicate only the color of the ink used. Here is how a set of items should look when completed.

red	blue	red	blue	orange	red	red	orange	blue
O	G	B	O	R	O	G	B	R

blue	green	red	red	blue	blue	red	blue	orange
G	O	G	O	R	O	B	R	B

THE ITEMS MUST BE COMPLETED IN ORDER beginning at the top of the page and working each row from left to right. Do not omit any items.

This test is highly speeded, so work as quickly as you can without making errors. There will be four separately timed parts. Wait for the signal before turning the page. Remember, work as fast and as accurately as possible.

APPENDIX G

Speed of Form Discrimination Test

SPEED OF FORM DISCRIMINATION TEST

The following items consist of the letter D presented in sets of seven. These sets are printed in three different kinds of type: capitals (DDDDDDD), noncaps or standard lower-case type (ddddddd), and italics (*ddddddd*). Here are some sample items.

DDDDDDD	ddddddd	*ddddddd*	ddddddd	*ddddddd*	DDDDDDD
ddddddd	DDDDDDD	ddddddd	DDDDDDD	ddddddd	*ddddddd*

You are to print under each set the first letter of the name of type in which the set is printed. Print C under each set of capitals, N under each set of noncaps, and I under each set of italics. Here is how a set of items should look when completed.

ddddddd	DDDDDDD	ddddddd	*ddddddd*	ddddddd	ddddddd
I	C	N	I	N	N
DDDDDDD	*ddddddd*	DDDDDDD	ddddddd	DDDDDDD	*ddddddd*
C	I	C	N	C	I

THE ITEMS MUST BE COMPLETED IN ORDER beginning at the top of the page and working each row from left to right. Do not omit any items.

This test is highly speeded, so work as quickly as you can without making errors. There will be four separately timed parts. Wait for the signal before turning the page.

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

The following items consist of the names of three kinds of type: capitals, noncaps (standard lower-case type), and italics. Each of these three type names may appear in any of the three kinds of type. For example, the name "capitals" may be printed either in capital letter (CAPITALS), in noncaps (capitals), or in italics (*capitals*). Here are some sample items.

noncaps	CAPITALS	italics	NONCAPS	*italics*	*noncaps*
ITALICS	*noncaps*	*italics*	capitals	NONCAPS	italics

You are to print under each word the first letter of the <u>name of type</u> in which it is printed. Print C under each word <u>printed in capital letters</u>, N under each word <u>printed in noncaps</u>, and I under each word <u>printed in italics</u>. Ignore the meaning of the words themselves and indicate only the kind of type used. Here is how a set of items should look when completed.

italics	ITALICS	*noncaps*	capitals	NONCAPS	*capitals*
I	C	I	N	C	I
italics	noncaps	ITALICS	*noncaps*	italics	capitals
N	N	C	I	N	N

THE ITEMS MUST BE COMPLETED IN ORDER beginning at the top of the page and working each row from left to right. Do not omit any items.

This test is highly speeded, so work as quickly as you can without making errors. There will be four separately timed parts. Wait for the signal before turning the page.

DO NOT TURN THE PAGE UNTIL YOU ARE ASKED TO DO SO.

APPENDIX H

Speed of Number Summation Test

SPEED OF NUMBER SUMMATION TEST

Each of the following items consists of two sets of tally-marks joined by a plus sign. You are to add the number of tally-marks in the first set to the number in the second set and record the sum in the blank space provided. For example:

1111 + 111 = 7 11111 + 111 = 8 1111 + 1111 = 8 111111 + 111 = 9

THE ITEMS MUST BE COMPLETED IN ORDER, beginning at the top of the page and working each row from left to right. Do not omit any items.

This test is highly speeded, so work as quickly as you can without making errors. There will be four separately timed parts. Wait for the signal before turning the page.

Remember, work as fast and as accurately as possible.

DO NOT TURN THE PAGE UNTIL ASKED TO DO SO.

Each of the following items consists of the names of two numbers joined by a plus sign. For example:

three + eight = ___ two + one = ___ nine + zero = ___ six + four = ___

You are to add the number of letters in the first name to the number of letters in the second and record the sum in the blank space provided. Ignore the meaning of the words themselves, and indicate only the number of letters involved. Here is how a set of items should look when completed.

three + eight = 10 two + one = 6 nine + zero = 8 six + four = 7

THE ITEMS MUST BE COMPLETED IN ORDER, beginning at the top of the page and working each row from left to right. Do not omit any items.

This test is highly speeded, so work as quickly as you can without making errors. There will be four separately timed parts. Wait for the signal before turning the page.

Remember, work as fast and as accurately as possible.

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13. ABSTRACT

The perceptual style known as field independence has been defined by various investigators as the ability to perceptually separate an object from within a complex background. This investigation attempts to test this concept in a literal manner by examining the relationship between several established measures of field independence and performance on a real-life visual detection problem.

Only one of the instruments used, the Hidden Figures Test, correlated significantly with performance. An added finding was a correlation between performance and general intelligence. Furthermore, interest correlations showed that the instruments used could be divided into two groups, each measuring what appears to be a separate quality of the field independence concept.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Field dependence						
Visual detection ability						
Perceptual style						
Camouflage						
Embeddedness						
Distraction						
Intelligence						
Detection						